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INDUSTRIAL EVOLUTION
IN INDIA

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BY
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PREFACE

The first chapter on "the Indian Industrial Problem" was originally written for "Science Progress" and is now reprinted by kind permission of Mr. John Murray. The other chapters are mainly selections from papers contributed to the Indian Industrial Conferences and to the South Indian Association and from articles written for the "Hindu," whilst the two concluding chapters were originally addressed to the students of the Central Technical College, South Kinsington. A considerable amount of revision has been necessary to embody the results of more extended experience in dealing with the questions discussed.

To a large extent these papers are a record of the work done in Madras during the past ten years, but as there is a general similarity in the conditions all over India it is possible that they may be of assistance to those interested in the industrial progress of other parts of India.

Much controversy has raged round the question of the extent to which the State may directly intervene to promote the welfare of indigenous industries and as it is still *sub judice* with the Secretary of State, except in general terms any reference to it has been omitted as I hold strongly to the opinion that our industrial policy must be framed to suit the exigencies of the political situation. The benefits which India derive from British protection far more than counterbalance any disadvantages which may arise from the necessity of submitting to the decision of the Home authorities in such debatable matters as come within the

PREFACE

sphere of Indian economics. Industrial progress is essential to the maintenance of peace and contentment in India and that fact is clearly recognised by the statesmen who have the final voice in determining the course of Indian affairs. What seems to be needed is a stronger and better informed public opinion, both in India and Great Britain, on the commercial advantages which will accrue to both countries from a more extended development of the latent resources of India both agricultural and industrial. The trade between the two countries is already large and with increased production of wealth in India it will enormously extend.

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INDUSTRIAL EVOLUTION IN INDIA

CHAPTER I

THE INDIAN INDUSTRIAL PROBLEM

THE NEED OF A SYSTEM OF INDUSTRIAL TRAINING

THE publication in 1884 of the Report of the Royal Commission on Technical Education drew the attention of administrators in India to the fact that no adequate provision had been made by the Indian Educational Departments of systematic instruction in the scientific principles underlying industrial processes. The interest of the educated public was languidly excited and vague notions became current that the acknowledged decay of Indian manufactures could be arrested if arrangements were made to remedy the defects in the existing educational machinery. Accordingly, in the course of the next few years, each Province took action in this direction and sanction was accorded to such measures as the local governments considered to be immediately necessary. One result of the application of European ideas on the subject of technical education was the establishment of the Victoria Jubilee Technical Institute in Bombay, where the cotton-spinning industry was already firmly established ; as another result the engineering school at Seebpore, near Calcutta, was reorganised and expanded to provide for the needs of Bengal, where the

manufacture of jute, coal-mining and mechanical engineering were local industries of considerable and growing importance. Both these institutions are now valuable centres of recruitment for the organised industries of their respective Presidencies ; that they have not reached the standard of excellence we are accustomed to expect in similar institutions in Europe and America is due to the fact that Indians do not regard an industrial career with any favour ; they only take to it when they are convinced that they have no prospect of success in more congenial occupations.

In other parts of India it was obvious that modern industrial enterprise was too feebly developed to support either specialised technical schools like that devoted to the cotton industry in Bombay or a general engineering school like that at Seebpore. In Madras, however, an original attempt was made to create a demand for technical education by providing facilities for the examination of students in a great variety of technical and industrial subjects. The scheme was modelled on the lines of the examinations of the Science and Art Department and of the City and Guilds of London ; it has proved of little value, though it has supplied convenient tests of the training given to pupils in trade and elementary engineering schools.

The only practical outcome of these early attempts was to strengthen the staff and improve the equipment of the existing engineering colleges at Roorkhee, Poona and Madras, where Indians are trained for the various branches of service in the Public Works Department. Unlike Seebpore, where most of the students find employment in the industrial undertakings of Bengal, these institutions are intended to supply the very considerable demands of the provincial Governments, native

states and district boards for men to carry on the current engineering work of the country in connection with railways, roads and bridges, irrigation, buildings and general municipal work. Mechanical engineering is not entirely neglected but it is regarded as subordinate to civil engineering, hence probably the limited degree of success hitherto attained by Indian engineers in the practice of a profession which calls for an intimate acquaintance with the materials and methods employed in construction. For a long time these colleges were not very popular, notwithstanding the fact that a number of well-paid Government appointments were guaranteed to the students who completed full courses of instruction ; of late years there has been a great change, the competition at the entrance examinations being now very keen. Apart from the too early specialisation in favour of civil engineering, the work done in these colleges suffers from the defective previous training of the students ; but little improvement can be expected so long as the general education of the country is dominated by the Universities. The reforms which have been introduced, since the report of the Universities Commission, have done something to raise the general tone of Indian education but they have done little or nothing to render it of a practical character. It seems almost certain that another educational system is required that will provide for the industrial needs of the country, entirely independent of the control of the Universities.

For the indigenous industries of the country, which are entirely in the hands of illiterate artisans, it was not deemed possible to make any provision. The first attempts to deal with industrial education were made by missionaries, who started schools for the instruction of orphan boys in their charge in such trades as carpentry, weaving and blacksmiths' work. Subsequently the idea was

developed, chiefly by local bodies, and encouraged by Government grants-in-aid. At first the main object of these schools was to break down the exclusiveness of the caste system; later, to improve the hereditary methods of the artisans; the admittedly small measure of success they have achieved is roughly proportionate to the extent to which they have influenced the conservative mind of the Indian hand worker. As schools for the industrial training of boys they have not so far justified their existence but in some instances as demonstration-workshops they have had a beneficial influence on the industrial centres in which they are situated.

At first the cry for technical education in India was but a feeble echo of that raised in England and awakened no response from the educated classes. There was a demand for the services of university graduates and they could readily obtain employment; the rest of the country did not count. All the technically trained men required for Government and for the industrial concerns working on modern lines were obtained from Europe; India was satisfied to see its sons finding congenial careers in the administrative services of the country, in the learned professions and in the educational institutions, which were rapidly expanding. From the early nineties onwards the supply of university graduates began to exceed the demand and year by year the competition has been steadily increasing, with the inevitable result that attention has been turned to other spheres of activity. When it was found that a university training and a university degree were no passports to an industrial career, a genuine demand began to assert itself for technical education and it was soon found that no provision had been made in the country to meet it. A few enterprising youths sought in Europe what they

could not obtain at home, to meet only with bitter disappointment on their return. Their education in India was found to be an unsatisfactory preparation for foreign technical schools ; they benefited little by their studies and returned to India completely lacking that practical knowledge and experience which are absolutely essential to success in an industrial career. Gradually it has become evident both to the Government and to the educated classes in India that industries must precede technical instruction and that any future industrial development must follow on the lines which have been so successfully pursued in the case of the cotton industry in Western India, the jute and mining industries in Bengal, the leather and cotton trades of Cawnpore and the many miscellaneous industrial undertakings which have been successfully established in every province of India.

THE LACK OF NATIVE INDUSTRIAL LEADERS

It is now fairly generally accepted that technical colleges in India can only do useful work when they train students for whose services there is a demand in existing industries and that the pioneer work of starting new industries must be undertaken by men who have acquired their skill and experience in other lands where those industries are carried on under favourable conditions. The establishment of technical schools, like the Victoria Technical Institute in Bombay, in other parts of India is now recognised as useless, unless there is a corresponding industrial development to be catered for. Only in Bengal can it be said that this state of things exists ; the Seebpore College already makes fairly adequate provision for the needs of that part of India.

The increasing pressure of the educated classes in the more favoured fields of employment can only be relieved

by providing new openings for them in other directions and of these by far the most important will be found in the organisation of the immense resources of India for industrial undertakings of many kinds. A great deal has already been done in this direction by European initiative; the reason why the actual benefit to India has not been greater is the fact that Indians have, as a rule, stood aloof. The original impulse, capital and directive energy came from abroad, India having only furnished the raw material and the labour. The profits have been taken out of country year by year, but of greater moment is the fact that there has been no gradual growth of industrial experience, so that to-day, except perhaps in the cotton trade, India lacks native industrial leaders. The men with capital, business acumen, technical knowledge and administrative capacity, who form the backbone of industrial life in Europe and America, are lacking and no preparation has been made to create them. Development in the immediate future, as in the past, must mainly depend on men not born and bred in the country and who will only remain in it for a time, taking with them, when they leave, the experience they have gathered. A change is possible—it may be even said to be inevitable—but it can only be brought about slowly. Indians have begun to appreciate the importance of industrial activity; they have started the Swadeshi movement to encourage it and by degrees they are learning the nature of the problem they have to face. A detailed history of the modern development of the cotton industry in Western India would furnish much useful information to those who are seeking for guidance as to the methods to be pursued to raise India in the scale of nations, to utilise her resources and to provide her people with something more than the bare necessities of life. There can only be a vigorous and healthy industrial

life when it is carried on by the people themselves—that is, they must supply the capital, take the risks, enjoy the profits, bear the losses and, above all, undertake the management and control of the many branches into which it is subdivided.

THE EXTENT OF NATIVE RESOURCES

The labour problems in India are not serious ; there is plenty of labour, although the standard of efficiency is very low and there is a sad lack of energy and staying power, partly attributable to climatic causes and partly to the low standard of living. The small wages paid for such labour compensates for its disadvantages in a commercial sense and it is certain that as progress is made there will be a corresponding improvement in the condition of the working classes—their output will increase and their wages rise ; if education be spread among them, their wants will become more numerous and gradually they will emerge from the thraldom of conservatism and prejudice which dominates them and strangles all aspirations for any higher state of existence than that which they now enjoy.

Of capital there is plenty in the country and year by year it is accumulating ; but the people do not know how to use their wealth and it is uselessly hoarded in the form of gold, silver and jewellery. There is a general impression that in India too large a proportion of the population is dependent upon agriculture and that the establishment of new forms of industrial enterprise on modern lines has not compensated for the decay or extinction of indigenous industries. It is suggested that there has been a one-sided development of the natural resources of the country and that in consequence the people are unduly exposed to the perils of famine and scarcity. During the last half-century

the indigeneous industries have been subjected to ruinous competition with imports from abroad, as a result of which the condition of the artisans has steadily deteriorated. Probably, however, their numbers are actually larger and the amount of their output greater than at any previous time. It is the margin of profit which has almost vanished, with the natural consequence that widespread poverty and destitution have taken the place of a state of comparative affluence. Caste restrictions, combined with ignorance and intense dislike to change of any kind, have kept the artisans to their hereditary methods and in the absence of any external assistance they have only been able to face their difficulties by selling their labour at lower and lower rates, till all they can now obtain is scarcely sufficient to provide for a bare subsistence. On the other hand, during the last seventy years, agriculture has greatly expanded and by the extension of irrigation it has to a large extent become independent of the vicissitudes of the seasons over very considerable areas. The soil of India is rich and when supplied with sufficient moisture and manure yields an abundant harvest. In good years it supports the vast population with ease and yields for export agricultural produce to the value of more than one hundred millions sterling. Some of this is in a manufactured state but the bulk goes out as raw material and it is this enormous quantity of raw material which offers a field of development to those who are interested in the creation of an industrial India.

The charge is often made that British rule in India has brought about an impoverishment of the people and that they are worse off now than they were under the Moguls and their own princes. The charge is easily made and difficult to disprove, as but little is known of the condition of the people before the rise of British power. The standard of living is very low among

the great bulk of the population ; it is hardly possible that it could have been much lower but the numbers to-day are certainly double, possibly treble, what they were three centuries ago. Famine and plague still devastate the land but their terrors are much diminished and the ravages of war and intestine feuds have entirely ceased. Roads and railways have opened up the country, irrigation works have converted waste desolate tracts into fertile fields and the *pax Britannica* ensures to every man the enjoyment of his possessions ; but the people themselves have not changed—their ruling passion is still to hoard their wealth in a portable form and they still live much as their fore-fathers did. The main result of British rule has been a startling increase in numbers rather than a marked rise in the standard of living.

A striking commentary on this unproved charge against British administration is that in the five years, ending with April 1908, the net imports of bullion into India amounted to £92,287,000, nearly the whole of which has gone to increase native hoards of precious metal, that still represent to the people the most desirable form in which to accumulate wealth. This, it must be remembered, is in addition to the gold raised in India itself, which amounted during the same period to more than ten millions sterling. For all practical purposes these hoards are useless, save as an indication that the material development of India under foreign stimulus is really at a faster rate than that at which the people are deriving benefit from it.

What a capital expenditure of twenty millions a year would effect in India may be inferred from the fact that in a single year it would furnish sufficient capital to establish the whole of the cotton mills of Bombay and of the jute mills of Bengal. In a year and a half it would provide the forty-four crores of rupees which the Irrigation

Commission reported could be judiciously expended by Government in bringing a further six and a half million acres under irrigation. It is five times the whole amount annually spent on education—on the education of an empire containing three hundred million people—and it is approximately equal to the land revenue of the whole country and to the total annual expenditure in the military department. Surely, then, it cannot be contended that when so large an amount is put on one side every year and merely hoarded, that the people are becoming poorer? Is it not rather fair to assume that they are accumulating wealth faster than they know how to use it ?

Various estimates of the hoarded wealth of India have been made but they are all mere guesses and it would perhaps be unwise to give further currency to them ; it suffices for our purpose to assume that the sum-total is very large and that it is enormously greater than any possible demand, that can be made for generations to come, for capital for the development of the country. From an international point of view this hoarding of gold in India is of great importance in preventing an inconvenient depreciation of the monetary standards of the world ; in time to come, when the folly of the practice has been recognised, the dispersal of these hoards may be equally serviceable ; in maintaining equilibrium, if the productiveness of the mines should fall short of the demands of an ever-increasing traffic and commerce. This service India renders to the world at large and its people pay the cost not grudgingly but with a cheerful alacrity which is the outcome of extreme simplicity.

It must be remembered that this hoarded wealth is very generally diffused and that it can only be rendered useful by concentration in the hands of a comparatively small number of men who are competent to assume the responsibility of

directing the enterprises which can be started by returning it into circulation. This implies the existence of an instinct for co-operative working that at present is but slightly developed ; also a knowledge of and desire to participate in the amenities of life which our modern civilisation offers; finally, what is in no way less important than these, an intelligent comprehension of the elementary principles of credit and finance, without which it is impossible to create the feelings of security and confidence which form the basis of commerce and industrial enterprise.

NEED OF EDUCATION

It is only by educating the people that any progress can be made in this direction, and the efforts now being made to extend primary education may be viewed with intense satisfaction by all who are interested in the welfare of India; but much more might be done than has so far been attempted. In the year 1907-8 the total expenditure of British India on education was £4,018,764 or slightly over four pence per head of the population. This is not extravagant, but in the native states it is even less and if a rational system of education can be devised to meet the requirements of the people, it is certain that it would be wise policy to increase very largely the expenditure under this head, as such expenditure would greatly promote the moral welfare and material well-being of the people. The finances of India are in a flourishing state, the incidence of taxation is light and the natural growth of revenue is equal at any rate to the demands upon it. This is due to the excellence of the administration, which exercises a most careful scrutiny over the spending departments of Government, although it is possible that, in the laudable desire to prevent waste and to keep down taxation, economy has been effected at the expense of

national well-being. Any material increase of the grants for education could only be secured by fresh taxation but the necessity for such is now so great that it may well be urged that delay is prejudicial to the best interests of the country. Any form of direct taxation would be extremely unpopular but an increase of fifty per cent in the very moderate import duties would probably be welcomed and would yield about two millions a year. This would be sufficient to provide for that re-organisation of the educational system which is so urgently needed to prepare the way for a general improvement in the condition of the vast population by teaching them how to make better use of their enormous capacity for labour and how to exploit the natural resources of the soil so that it may yield a return commensurate with its extent and richness.

The suggestion that the increased expenditure which it is advocated should be incurred to remedy the defects of the present educational system may be met by increasing the tariffs on imports naturally raises the question : Why not give India an avowed protection tariff and under the shelter of that tariff build up an industrial system adequate to the needs of the country? That it could be done in this way there is no doubt but the people of the country could not do it and it would have to be done with imported capital and imported brains. The urgency for industrial development in India is mainly due to the limited field that at present exists for the employment of the rapidly increasing educated classes. It is essential that suitable work should be found for them and it is quite certain that if inducements were created to invest capital in India, the investing capitalists would send out their own men to look after and manage their interests. The people of India will be welcomed as "hewers of wood and drawers of water" but in no other capacity. Further

it must not be forgotten that the ultimate authority on the Government of India is the British democracy, whose opinions on fiscal matters are very unstable. If the erection of a tariff wall were sanctioned by one Parliament, it is by no means unlikely that it would be pulled down or materially altered by some later Parliament. With a tariff wall there would always be some uncertainty as to the continuance of the protection which it would afford, and in proportion to the intensity of the feeling of uncertainty this would militate against its efficiency as a factor in creating industries in India. The conditions in India are such that State intervention is necessary to bring about the economic changes under discussion but it should be directed to assisting the growth of private enterprise in the country rather than to the maintenance of an artificial barrier to the free exchange of commodities with the rest of the world.

By far the most important matter for the State to deal with at the outset is the establishment of an educational system which, from the primary stages upwards, will be practical rather than literary. Every Indian boy grows up in a certain environment and the education given to him should have reference to that environment and should aim at making him master of it. Hand and eye training, the cultivation of the powers of observation, the co-ordination of the various faculties in the service of their possessor—these should be the objects of educational processes, not merely the development of the mental powers along comparatively narrow lines. The present system of education has failed lamentably to produce men of action, with balanced judgment and sound constructive faculties. The memory rather than the imagination controls thought and in the absence of experience responsibility is declined. It has turned out good if not great lawyers, excellent

judges, a few engineers but no original investigators or deep thinkers.

THE LACK OF INDIVIDUALISM

It must, however, be admitted that it is not the education system alone that is at fault. In India the vitalising force of nationality is almost entirely absent and centuries of subjection to a foreign yoke or to the endurance of an almost continuous state of internal discord and anarchy have deprived the people of that individualism which finds its highest expression in collective effort. Social customs and caste restrictions militate against progress and the general prevalence of early marriages handicaps the race, not only by imposing the cares of domestic life upon students and even upon children who ought to be at school but also because such immature unions result in offspring deficient in physical vigour and lacking force of character. These are deeply rooted obstacles which cannot easily be removed. Emancipation from the tyranny of a grotesque and unique social code has begun and the movement for greater individual freedom of action will be accelerated by the increasing tendency of Indians to travel in other parts of the world. Climate again is a factor which must be taken into account—it induces indolence on the one hand and renders existence easy with but a moderate degree of exertion on the other. The position is one of extraordinary difficulty and complexity; the future well-being of India demands, in fact, a careful consideration of the various elements before any policy is finally framed to guide the administrator through the years of rapid change which lie before us. Educated Indians want work—there is work for them to do but it is work they dislike and their education has not removed their prejudices or rendered the task any easier by training them for it.

THE REVIVAL OF NATIVE INDUSTRIES

The educational methods can be changed but it will take a generation to show any result ; in the meantime the evils arising from the lack of suitable employment must be checked and a system of industrial development devised to deal with the existing state of things. Enterprise on a grand scale can be left to grow in the manner it has done during the last half century and at present need not concern us. Our attention should be concentrated on the decaying indigenous industries : hand-weaving, working in metals, tanning and leather manufactures, on all the petty industries which supply the simple needs of the people. Labour must be trained to work more efficiently —there must be less of brute force and more of skill, the primitive tools of the artisan must be superseded by better implements ; sub-division of labour must be introduced and from the crude simplicity of each family as a unit of productive effort strong combinations must be evolved, either by co-operative working, or by the concentration of manufacture in small factories. That this can be done there is not the least reason for doubt. Every well-directed effort that has been made on these lines has met with success and if so far the sum total of the results is insignificant compared with what has to be done, it is because the experimental stage has only just been passed through. Individuals scattered over India have attacked the problem according to their lights and, whilst many have failed, some have succeeded. A critical review of the circumstances of each case leads to the general conclusion that success has invariably been due to the application of scientific methods and practical experience ; that the failures might in most cases have been predicted from the outset, as essential elements to success were neglected and

more zeal than discretion displayed in dealing with the difficulties that had to be overcome.

It would serve no useful purpose to cite instances of misdirected enterprise the failure of which has engendered in Indian minds a deep-seated distrust of the tools and appliances which in modern times have so enormously reduced the amount of human labour to be expended in converting raw materials into a form suited to the needs of man. The poverty of India measured by European standards is undeniable but the requirements of the people are extraordinarily small and, except in times of famine, there is but little of the destitution and misery which are to be found in the great centres of civilisation. There are signs, however, that a struggle for existence is beginning to be felt, due to the increasing pressure of the population on the soil, to the expanding needs of the educated classes and to the growing inequality in the distribution of wealth. Within the last few years there has been a marked rise in the price of food grains, which presses severely on the landless labourers in the villages and upon the artisans and workers in the towns. The old order of things is changing, and India is being steadily drawn into the stream along which the nations of Europe and America are being hurried to a by no means clearly discerned destination.

There is in the country much unrest which is far from being of political origin. The problem for the statesmen, who will have to control the administration of India, is to provide outlets for this newly awakened energy and to direct it in such a manner as to satisfy the growing aspirations of the vast population. Hitherto, the intellectual classes of the country have held almost entirely aloof from the rest of the people, whom they have looked down upon and despised. They have left the working classes to face the growing difficulties of their position, careless of

everything outside the range of their own immediate interests ; now that they are forced by internal competition to take a broader outlook, they find themselves incompetent to deal with the practical problems which await solution ; to bring about a healthier state of things, it is necessary that means should be devised whereby they may be associated with the artisans and workers of the country to their mutual advantage. The future progress of India largely depends on the proper appreciation of her greatest asset—abundant cheap labour—labour at present not without some measure of skill but almost entirely untrained and unorganised.

THE NEED OF STUDYING LOCAL CONDITIONS

Our work is to show the educated classes how they can find useful careers, honourable and remunerative employment, work that will benefit both themselves and the whole community in supplementing the deficiencies of the workers, in dispelling their ignorance and softening their conservatism.

First we must train them in our schools and colleges, then in our workshops and laboratories and finally we must start them in life, giving them practical work to do under competent supervision until they get accustomed to the new atmosphere and surroundings and are able to launch forth by themselves. But we ourselves have to discover how this may best be done ; we must call to our aid all the resources of science and obtain the services of experienced men to study the local conditions. It will be for them to train our students, make surveys of the existing industries, take stock of the natural advantages, search for hidden resources and suggest new lines of work and innovations which may be introduced.

In regard to matters purely agricultural, this

procedure has already been adopted by the Government of India and by all the Provincial Governments. At Pusa an Imperial College of Agriculture has been started, a staff of highly competent scientific and practical experts appointed, an experimental farm has been laid out and for some years past the many problems of Indian agriculture have been the subject of close study and unremitting investigation. Valuable results have already been obtained. Each Province has been provided with an Agricultural Department on similar lines, the officers of which deal with the special problems of the Province and by demonstration farms, by direct teaching and by personal intercourse with the people on the land make them acquainted with new discoveries, new crops, new implements and the advantages of adopting improved methods of cultivation. The great primary industry of India is well provided for and in the years to come the country at large cannot but greatly benefit by the thorough and patient way in which the capabilities of the soil are being examined.

The lengthy discussions on the methods by which the industrial problems are to be solved have not yet crystallised into the form of a comprehensive declaration of policy on the part of the Government of India and the Secretary of State. The various Provinces have examined the question, have submitted proposals and in some cases have tentatively embarked upon active measures ; but no clear line of action has been marked out as in the case of agriculture. In the education departments, the need of improved science teaching has been admitted and, through the munificence of the late Mr. Tata and his sons, an Imperial Institute of Science has been established at Bangalore for post-graduate work and research, which should in time do a great

deal to attract the highest intellect of the country to practical pursuits.

The subtle mind of the Hindu delights in philosophic speculations and in unravelling the intricacies of legal enactments ; it is possible that the same qualities applied to scientific investigation would afford their possessors equal gratification in probing the hidden mysteries of natural phenomena. That the practical aspects of such inquiries would appeal to them is less certain but, whether or not, their work will be insensibly influenced by the growing need of the country for scientific help in solving the problems which the increased activity of the people will force upon public attention.

The important principle is gradually meeting with acceptance that scientific education must precede attempts at technical instruction and that the latter can only be usefully provided to meet the requirements of existing industries. So long as the great organised industries in the country are mainly controlled by Europeans, so long will the technical assistants be obtained from Europe, and Indians must go there for training and to acquire experience if they want to take a part in such work. This is tacitly admitted by the increasing numbers who year by year leave India to seek such instruction in countries more favourably situated for supplying it. The unfortunate feature in this movement is that the majority of the students who go abroad are inadequately prepared in the way of preliminary education to avail themselves of the facilities which they find placed at their disposal and they are in almost every case quite unable to supplement the purely college courses of technology by practical experience in workshops and manufactories, without which their whole training is imperfect and useless. Not till Indian capital finances Indian

industries will the people gradually be able to acquire that experience which it is necessary they should possess if they are ever to manage their own enterprises successfully. The fact that this has to a large extent been accomplished in the cotton trade in some degree accounts for the remarkable progress of that industry.

The cotton and jute industries, and mining for coal in Bengal and for gold in Mysore have developed because of certain natural facilities or because of the existence of easy markets in which the products were in demand, but the bulk of the industrial work of India is languishing in face of the competition with imports. The external trade of the country has grown at the expense of the internal, resulting in an unhealthy and one-sided development of the country's resources. Roads, railways, telegraphs, the construction of the Suez Canal, every improvement in the means of transport both by sea and land has contributed to the difficulties and, in many cases, to the ultimate discomfiture of the Indian artisan. The attention of Government has been almost entirely directed to the opening up of the land, to the provision of irrigation ; assistance has in more than one case been given directly to the efforts of English manufacturers to exploit Indian markets, whilst the industrious artisan has been left severely alone to combat as best he can the growing difficulties of his position. That he has survived so long may be taken as evidence of the possession of certain elements of vitality and as affording justification for the hope that a permanent place may be found for him in the industrial future of India. What we have to do is to supply the artisan with all those factors that contribute so largely to industrial success, in which he is so conspicuously deficient. He lacks capital and organisation, his tools and implements are primitive and imperfect, he has no commercial

knowledge and in his dealings with the outside world he is almost always in the hands of money-lenders and petty traders, who make their profit out of his helplessness and strenuously resist any attempts to improve his position that would render him independent of their aid. He is industrious and would be intelligent were it not that his faculties are undeveloped owing to the narrow field in which there is scope for exercising them. His technical knowledge is a negligible quantity and of improved trade processes and methods he has but a slight acquaintance.

It would however be far from the truth to say that he has remained entirely uninfluenced by the progress made during the last century. A few typical illustrations will serve to indicate one of the directions in which we must look for advance. (1) The ryot, who grows sugarcane, has entirely discarded the old wooden mills in favour of those made of cast iron, with the result that the work is done with less labour and a higher percentage of juice is extracted. (2) In many parts of the South of India the weavers prepare their warps on rotary mills and in some places the advantage of subdivision of labour is so far recognised that the preparation of warps on these mills has become a distinct business. (3) The extraction of oil from seeds is largely done in screw presses worked by hand in place of the old-fashioned rotary wooden mill. (4) The fly-shuttle loom has been substituted for the native hand loom among the weavers of certain districts of Bengal, with the result that their speed in weaving has been doubled. (5) Wood and metal workers almost invariably use some tools of European manufacture. (6) Singer's sewing machines are to be found in almost every tailor's shop in the country and, although these machines are somewhat delicate and complicated pieces of mechanism, the facilities for the repair or renewal of parts have been so wide-

ly diffused that the tailors find no difficulty in keeping them in working order.

It would be easy to multiply illustrations of this kind, especially in regard to agriculture and its dependent trades and those industries which have been influenced by the workshops and factories to be found in the centres of modern industrial activity. We may rest assured that there will be no opposition to the introduction of improved tools or improved methods of working if it can be clearly shown that they are real improvements. The reputation that Indians are averse to all change and are obstinately wedded to the antiquated ways of their fore-fathers is not justly deserved. They are conservative but they know their own business fairly well and many of the so-called improvements which they have rejected were really unsuitable innovations.

THE DEVELOPMENT OF SMALL-SCALE INDUSTRIAL ENTERPRISES.

India offers a great problem to the civilised world. It has abundance of cheap labour which, if properly trained, would be skilled ; it needs to be shown how to apply this labour to the best advantage. The whole trend of modern progress has been to replace the man by the machine, to replace the individual by the factory and the isolated factory by the organised trust. Where labour is dear this system has developed most largely and human ingenuity is ever exercised in extending the scale of operations. We have introduced the system into India but it has not yet taken root. We may either regard it as inevitable that it should ultimately be established or we may adopt an alternative and apply the resources of science, engineering and commercial experience to a great attempt to raise the worker and pit his

skill, ingenuity and adaptability against the monstrous growths produced by the abnormal development of the mechanical arts. The problem ever before the modern industrial world is to devise means of dispensing with labour, to cheapen production by making it more automatic. The success has been remarkable but it has been purchased somewhat expensively ; it is possible that we might now with advantage turn our attention to developing the function of the man rather than the power of the machine, to evolving a system the object of which should be to employ human labour to the greatest extent possible and in the way most advantageous to the individual man.

The conditions in India are suitable for such an experiment. It has not yet accepted the factory system nor will it do so willingly, the undivided family has to be reckoned with and the extreme sub-division of property renders productive effort on a large scale difficult. Comfort rather than luxury, a moderate rather than a vast fortune—these are the ideals of enlightened Indians. It would be foolish to imagine that, as India now stands in relation to the British Empire and to the rest of the world, it could disregard the external influences to which it must always be subjected but there is no reason why it should not strive to move forward to a goal more in harmony with its own traditions than is that presented by Western civilisation.

In England, America and Australia there is a widespread movement in favour of small holdings instead of large farms and much evidence is now available to show that where the conditions are suitable this method of cultivation tends to the more general diffusion of prosperity and contentment. In India small holdings are universal. Industrial operations, except in so far as they have been changed by the advent of Europeans, have also been

carried on by men of small means and they have survived to the present day mainly because of the inherent vitality of such a system. There is no necessity to abandon this way of working but we must improve it and bring the status of Indian artisans to the same level as in other countries, which have in recent years made so much progress.

There are greater prospects of the small manufacturer, being able to compete with the big than there were a few years ago, as recent progress in science and the mechanical arts has done much to raise the efficiency of working on a small scale. Not by any means in all directions but in some, and those more particularly which are likely to flourish in India. The cost of power has been enormously reduced especially in the case of very small plants, so that the small user of power is in a much better position to compete with the large user than was possible only a few years ago. There is in consequence a perceptible reaction against production on a large scale and a tendency to make greater use of the elasticity which allows small works more readily to adapt themselves to changes and fluctuations in trade, cyclical or otherwise.

Again it is evident, even in the most highly developed industrial countries, that the human factor is becoming more important and in the distribution of profits between capital and labour the latter is demanding a larger share. It must not be imagined that the great primary industries are materially affected in this way—they are not and it might even be contended that the ever-increasing perfection of mechanical appliances is rendering the labour question one of constantly diminishing importance. With this phase of industrialism we are not at present concerned. It may be fully trusted to look after itself, but there is no likelihood that it will ever be greatly developed in India

excepting in certain localities. The main reason for this is that over the greater part of the country there are no special natural resources.

There is no doubt that the various castes and groups of artisans in India maintain themselves against the present competition of European industrialism and that although they may have suffered severely, they have not succumbed. Equally it is certain that much could be done to render their work more effective both by improving their methods and by supplying their trades with a commercial organisation that would bring their products into the markets where the demand is greatest. Obviously Government is the only agency by which such a change can be brought about; the greatest difficulties will probably arise from the opposition of the artisans themselves, who care little about education and are averse to abandoning the free and improvident life they have always led. In framing a policy the provision for a suitable education must come first. It must be of a simple character and have a direct bearing upon their future prospects. It must appeal to the people and attract them by its direct reference to their everyday life and, above all, it must not be regarded as the first rung of a ladder which will elevate a few above their fellows; its object should be to raise the mass from their lethargy and ignorance to a higher level, whence in due time a fresh start may be made. For the present, possibly for a long time to come, we must look to the educated classes, as we now understand that term, to furnish the men who will lead the industrial groups and bands which it should be a primary duty to organise.

IN India provision must be made for training the men diverted from literary pursuits to take an active part in the re-establishment of the hereditary artisans of their native

land. It would be premature to discuss the details of the training, as that must depend on inquiries and researches not yet made. Certain general principles are of application from the outset. There must be trade schools in which foremen can be trained for specific industries and these should be furnished with a model equipment the value of which should be clearly demonstrated under strictly practical conditions. In order that hand labour may be developed to its highest possible efficiency, it is essential that the appliances, tools and machinery should be maintained in the best possible order ; mechanical workshops will be required to train fitters, mechanics and carpenters, and to afford instruction in the elements of mechanical engineering which underlie and are necessary to all manufacturing processes. Lastly, technical colleges and schools of science will be required, in which the best intellects the country can place at the disposal of its industries will be prepared to take up the leadership and carry on the work initiated by those having qualifications acquired abroad who will act as pioneers to the movement.

India sustains great loss and will continue to suffer so long as the best of her sons devote their energies and abilities almost solely to the legal profession and Government service ; such service, however valuable it may be, does not directly contribute to the material welfare of the community. In any country litigation is a necessary evil but it is ten times worse when it is allowed to absorb such an enormous proportion of the available trained intelligence as is the case in India. There, the legal profession is unduly prominent and its ranks are consequently overcrowded. Litigation is fostered and the growth of technicalities stimulated, so that the machinery of justice is clogged. Indians are naturally prone to resort to the law courts on every possible occa-

sion, the luxury of a civil suit having a strange fascination which few who can afford it succeed in withstanding permanently. The introduction of new interests into the life of the people would tend to check this tendency; anything that will create a wider outlook and broader views should be encouraged. The backwardness of India is not a little due to this parasitic growth and it is time that it was checked. The diversion to industrial pursuits of part of the stream of graduates flowing from the universities is a promising antidote and will perhaps gradually educate the public to consider the man who devotes his life to the promotion of the well-being and prosperity of his fellows deserving of greater honour than he who keeps them at variance and battens upon their failings and misfortunes.

THE POSSIBLE INDUSTRIAL FUTURE OF INDIA

We are come now to the last stage in our discussion of India's future industrial position and that is to illustrate by concrete examples the possibility of working upon the lines briefly indicated. It has been assumed that her industries can be developed without leading to the hideous concentration of human life and human activity in smoke-begrimed cities, with unparalleled luxury for the few and squalour for the many. This is based upon the idea that our ever-increasing command of natural forces will enable us to operate with equal advantage on a small as on a large scale; that there is a reaction against the deadening influence of production by machinery, in favour of the greater variety offered by products into the fabrication of which individual skill and fancy have been allowed to enter; that, as there is therefore a field for Indian labour which can be developed by a judicious combination of the man with the machine, the former should be trained to afford the fullest possible play to his God-given faculties

and that mechanical ingenuity should be directed to providing him with the means to exercise those faculties to the greatest possible advantage.

The problem to be solved is the difficult one of finding the happy mean between the individual working for himself and the great capitalistic organisation employing thousands of operatives in lives of monotony and drudgery. The single man or family is too small an economic unit to succeed, the modern mill or factory entails too much social degradation to be encouraged. The free play of private enterprise in the West has produced an unstable civilisation, in which the various elements are in antagonism with one another. Is it necessary that India should follow on the same lines? Is it not rather worth our while to attempt to direct her course so that advantage may be taken of the experience that has been gained to avoid, as far as may be, the unhealthy and undesirable features which are becoming so prominent in Europe and America?

The Government are clearly justified in intervening to prevent the artisan, if they can, from being driven out of his hereditary calling and to start him upon a new line of progress that will not land him in the evil plight that has befallen his fellows under the modern industrial system. The object to be obtained is the amelioration of the condition of vast numbers of people and not the creation of opportunities for concentrating great wealth in a few centres and in the hands of a small minority of the population. If this premiss be accepted, the problem should be studied with a view to working along the lines indicated and such assistance obtained from outside as is likely to prove useful. Much work has already been done by such scientific services as the Geological Survey of India in determining

the available mineral resources, by the Forest Departments of the various provinces in ascertaining and conserving the value of the vegetation, by the Public Works Department in its various branches in all that pertains to improving means of communication and utilising sources of irrigation. The scientist, the mechanical engineer and the manufacturer have all done something to demonstrate the value of these resources, which should now be examined in greater detail with the specific object of increasing the opportunities of the indigenous industrial population. Industrial experiment and investigation are required and for such, specially qualified men must be employed. Something in this direction has already been done and may be brought to notice, not because of its intrinsic importance but because it is pioneer work that will serve to show clearly the method adopted of solving this question.

Lifting Water.—The chief requisites of the Indian agriculturist are water and manure, both of which, in the absence of public sources of water supply, he has obtained hitherto through the agency of cattle. Water is lifted from between three and four million wells; as the quantity required is large, the expense is a very heavy charge upon the ryots. Careful investigation of the indigenous methods of lifting water demonstrated the high degree of efficiency attained in applying the power and no improvement seemed to be practicable until the oil engine became a source of motive power, so economical in fuel, so simple in action and involving so small a capital outlay that it was easily brought within the range of the wealthier ryot, who had a sufficient water supply, to justify using it to drive a centrifugal pump. In the South of India through Government agency large numbers have been installed and there is no doubt that their use will extend rapidly as their advantages become better appreciated. The

requirements of India in this direction have now attracted the attention of engineers in England and, especially since the invention by Mr. Humphrey of the gas pump, it cannot be doubted that there will be a rapid development of mechanical methods of lifting water on a small scale that will greatly conduce to the prosperity of the ryot and at the same time familiarise him with the advantages of employing better tools or appliances in his daily work. Where the individual ryots are farming on too small a scale, the advantages of a number co-operating are apparent and have already been utilised.

Searching for Water.—The application of the oil engine and pump to lifting water for irrigation has extended the range through which water can be lifted profitably and rendered it possible to go to greater depths in search of water. To facilitate this work boring tools have been introduced and through their agency valuable supplies have been discovered ; these have greatly increased the value of the land in the neighbourhood. The cost of a set of boring tools being beyond the means of individual ryots and special experience being necessary to make use of them, the work of boring for water has been taken up in some cases by public bodies and in others by private individuals who are making it a special business. An immense amount of work in this direction may profitably be undertaken in India but there are difficulties, especially in connection with deep boring, that render it desirable that Government should continue the work and assume the risks. So far the pioneer work has been done in an entirely haphazard way, though with great success. It now requires to be put on a more scientific basis under the direction of geological experts.

Leather.—The manufacture of leather is an old village industry which has been much affected by the growth of

the export trade in raw hides and skins and in partially tanned leather. This is by no means to be regretted, as the "chuckler" made very inferior leather and spoilt a vast quantity of valuable raw material. The modern chrome process supplies a material much better suited to Indian requirements; through the efforts which the Government experimental tannery in Madras has made, this is now becoming widely known and appreciated for such purposes as water bags, sandals, harness and boots and shoes. Small Indian tanneries are being started and afford excellent examples of what can be accomplished by private enterprise, either by co-operation or by individuals. The advantage to the country at large of the general employment of chrome leather will be very considerable, as it will reduce the Indian consumption of hides by approximately one-half and thus throw on the market for export a large quantity of raw material for which there is always a good demand.

Weaving.—This is the most important of the indigenous industries, and, despite the competition of imported piece goods and the products of the Indian power-loom factories, still gives employment to about two million looms. Much attention has of late been directed to the question as to how best to assist the hand-loom weavers and several new forms of hand-loom have been invented but none has as yet proved superior to the English hand-loom. The fly-shuttle is slowly making headway and will eventually be used by all plain weavers. By its use the rate of picking can be doubled but this does not mean that the out-turn of the weaver will be increased by the same amount, as extended observations show that the hand-loom weaver does not spend more than half his time throwing the shuttle, the balance being spent in mending broken ends, adjusting the warp and performing

other minor operations. Experimental weaving-sheds have thrown a good deal of light on the problems connected with this industry and there is now a fair prospect that eventually it will be put on a much more satisfactory basis. Indian methods of preparing the warp and of sizing and dressing it are in even greater need of improvement, and experiments are now in progress to determine how this can be achieved. The arrangement of the warp presents no difficulty, but the dressing, to obtain the same results as by hand-brushing, is still in the experimental stage.

It is much to be desired that the Lancashire weaving mechanicians should have their attention directed to the Indian hand-loom problem and efforts are being made to supply them with adequate data as a preliminary. What is wanted is an improved hand-loom and not a light power-loom driven by hand or by pedals. The material of which it is constructed should be of wood preferably and a high rate of picking is less essential than a gentle handling of the warp when opening the shed and when beating up. Some modification of what are known as "linen-dressing machines" will probably be found suitable but they have not yet been tried under the conditions which prevail in India.

Already a revolution is in progress in the hand-weaving industry, brought about by attempts to make practical application of the clearer knowledge we now possess of the conditions under which it has hitherto been carried on. Both brains and capital are flowing into it, to the advantage of the hand weaver and the general improvement of the relations between the artisan and the other castes. It is true that no great success has attended the efforts of those who have organised the hand weavers into small factories but they have managed to hold their own

CHAPTER II

PROTECTION IN INDIA

The science of economics has been defined as "the study of men as they live and move and think in the ordinary business of life." It is of western origin and its laws and generalisations have been deduced from the study of human life in temperate climates, under social and political conditions widely different from those that prevail in India. So far as it is an exact science, its laws are of universal application, but everywhere there is difficulty in collecting accurate data and in determining with precision the relative importance of the many factors which operate to produce a final result. Here, in India, we are beginning to recognise the extreme importance of economic questions and the necessity for independent investigations and research. The well-being of one-fifth of the human race depends largely upon a proper appreciation of economic forces and tendencies and it is a matter for congratulation that, of late years, there is distinct evidence that the leaders of Indian political life are honestly endeavouring to ascertain what light a study of economics can throw upon some of the questions they have introduced into their programme.

The spread of education has given rise to vague political aspirations and the unrest which is a symptom of the newly awakened mental activity sometimes exhibits itself in wild desires which beget excesses. The scum rises

and is an indication of the actions and reactions going on beneath the surface. The pressing problem of the immediate future is the provision of suitable employment for the ever-growing stream issuing from the portals of our schools and colleges. What have hitherto been recognised as the most desirable professions for educated men are full to overflowing and attention has therefore been directed to other possible spheres of employment. It is observed that in other lands industries and commerce absorb the energies of the bulk of the educated classes and it is noted that in India the indigenous industries are decaying, that they are without organisation and that they afford no prospect of employment for the educated classes. The great mass of the people are engaged in agriculture on so small a scale as to offer no opportunity for the utilisation of their services, and hence there has arisen a cry for industrial development which has found expression in what is called the Swadeshi Movement.

Naturally, attention has been directed to the protective tariffs imposed on imports by almost every progressive nation in the world, except Great Britain, and there is gradually growing up a deep-seated feeling that the free trade policy of the paramount power is injurious to the development of India and that, to a large extent, it is imposed on India from purely selfish considerations. The reaction in England against free trade has strengthened the convictions of those who advocate protection for infant industries in India and the resolution of the Allahabad Industrial Conference in favour of protection for the sugar industry and the still more recent resolution in the Imperial Council asking for the repeal of the excise duties on cotton may be taken as signs of the growing force of public opinion in favour of fiscal autonomy with the

object of introducing a revenue system of an avowedly protective character.

Although the day is undoubtedly very far distant when any such change in the relations between Great Britain and India is likely to become a question of practical politics, it is by no means of purely academic interest to discuss the fiscal policy imposed on India by the British Government. There is a strong feeling that Indian interests are sacrificed to those of England and that the policy prescribed for India is not so disinterested as its framers have hitherto proclaimed it to be. The sincerity of the motives which have actuated English statesmen is questioned, and in the controversy over tariff problems which has stirred the length and breadth of the British Empire, capital has been made by the Free Trade Party out of the difficulty arising from the Indian demand for freedom to impose protective tariffs in the interests of Indian industries. It is argued that so long as Great Britain adheres to her free trade policy, she is justified in imposing the same upon India, but where a protective tariff is deemed necessary in the interests of English manufacturers, no honourable course is open in regard to India, other than to allow the people of that country such assistance as they may also gain from a scientific tariff to protect their infant industries and encourage the establishment of new ones. The Tariff Reform Party is thus placed on the horns of a dilemma, since the gain which might be expected from the adoption of its policy would be more than counterbalanced by the restriction of business in India consequent upon the establishment of a protective tariff which would operate more severely against English manufacturers than those of other nations. :

It is quite outside the scope of my remarks this

afternoon to express any opinion upon the fiscal question except in so far as India is concerned, but I may venture to say that I entirely dissent from the proposition that India can claim to be regarded as a separate entity in fiscal matters. Even if the advantages accruing from a protective tariff in India were enormously greater than I hope to show that they are likely to prove, I cannot concede that India is justly entitled to act entirely in her own interests and without regard to those of Great Britain. In the last 50 years, during the whole of which the country has enjoyed, for the first time in history, profound peace and internal security, British statesmanship has been devoted to developing the resources of the country and increasing the material wealth of its people. Vast changes have taken place, and in the development of trade and commerce enormous vested interests have been created which must now be respected. A sudden change in fiscal policy would ruin thousands in England and cause widespread misery and destitution and it is more than problematical if it would prove of ultimate benefit to any one in India.

It is inconceivable that British statesmen will ever voluntarily agree to the erection of artificial barriers to the freedom of trade between Great Britain and India and the justification for this attitude is to be found in the history of the connection between the two countries. Not of set purpose nor as the result of deliberate policy, consistently pursued by generation after generation, has the whole of India been absorbed into the British Empire to share its prestige and enjoy its protection. By a series of accidents, rather than by design, the destinies of the two countries have become united and the unrestricted intercourse between the two has been of mutual benefit. Without thought of the consequences, the vital interests

of India have ever been uppermost in the minds of her administrators and, if the results have not always been completely satisfactory, credit at least may be taken for the purity and sincerity of the intentions. The opening up of the country by railways and roads, the construction of irrigation works and the maintenance of law and order have brought about an enormous agricultural development, which is reflected in the fact that the country supports 300 million people more readily than it supported 200 millions half a century ago ; and, at the same time, in normal years there is a surplus available for export, much larger than is necessary to pay for the imports and foreign charges. On the other hand, the improved means of communication, which have opened to the agriculturist the markets of the world, have brought the manufactures of the world to compete with the products of the indigenous artisans and in a large measure, owing to the complete absence of co-operation between the intellectual and the labouring classes, the result has been disastrous to the primitive industrial organisation prevalent everywhere. So long as the educated classes had full scope for the exercise of their energies in congenial forms of employment, they were indifferent to the fate of the artisans and were only too glad to avail themselves of the reduction in the price of commodities consequent upon the unrestricted admission of articles of foreign manufacture. But times have changed and they are now forced to look to the industrial work they once despised, for means to earn a respectable livelihood and for scope for the exercise of their trained faculties.

So far, except to a limited extent in the Bombay Presidency, it cannot be said that much success has attended the efforts which have been made to promote industries on modern lines and hence there has arisen a demand for

intervention, on the part of the State, to promote industrial development. Technical and Industrial Education, Provincial Departments of Industries, the pioneering of new industries by State Agencies and a Protective Tariff are all asked for, whilst a vigorous effort under the ægis of the National Congress has been made to create a strong public opinion in favour of locally manufactured goods. This movement has unfortunately failed, being to a large extent based upon sentiment, which has proved but a broken reed when it comes to laying out a limited amount of hard cash upon the necessities of life. The Bombay mill-owners have undoubtedly profited by it, but no one else has been able to take advantage of it, and the many ill-considered enterprises, enthusiastically started when the movement was acclaimed by the political leaders of India, have come to hopeless grief. It would be wise to let their memory sink into oblivion, were it not that they may still serve a useful purpose as object lessons for the future.

The failure has been attributed to a variety of causes and for each, remedial measures have been proposed, but at the root of the matter lies the fact that the people of this country do not possess, or at any rate possess only in a very limited degree, the essential qualities which make for success along modern industrial lines. Thrown into intimate contact with the progressive nations of the west and exposed to competition on all sides, there may be some inconvenience caused thereby, but assuredly there is no discredit in it. That the social system of India does not favour individualism, that the East and the West are as far asunder as the poles in their ideals of life, that the influence of an enervating climate operates powerfully against the strenuousness which is essential to commercial success, all these, are factors which must be taken into account and

it is obvious that the influence of heredity extended over twenty centuries and one hundred generations, cannot be eliminated by a sudden change in environment or by external pressure, however great it may be.

That India has a great future before it, I have not the least doubt, but it will have to work out its destiny from within, and create a new social order and a new civilization that will be great and durable in proportion to the degree of success achieved in adapting itself to the enlarged horizon which now surrounds it. Slavish imitation of the West is obviously to be avoided and in the matter which immediately concerns us, I hold that the revivification of its ancient industrial organization is of greater moment than the establishment of a modern factory system, concentrating enormous wealth in few hands and engendering socialistic tendencies among the vast mass of operatives that can only end in chaos and destruction. At the present time the situation is a difficult one, but let us not add to the difficulties by clamouring for action on wrong lines and asking for a policy which, if granted by the ruling powers, would make the people of this country slaves and helots to foreign millionaires.

During the last half-century, the material progress of India has been of a most satisfactory character and the recent cry for industrial development, comes from a small minority of unemployed educated people who have not yet found a suitable niche for themselves. On their behalf a great change in the economic situation is called for, and to promote the industries in which they hope to secure employment, a barrier to the free ingress of the products of the western world is to be erected ; free trade is to be abandoned and protective tariffs imposed. Fortunately, as I hold, in this matter the true interests of India and the obvious interests of England both lie in preserving the

existing state of affairs. There is no likelihood that the cry for protection will fall on willing ears, and no prospect whatever that it will be granted. Nevertheless it is necessary that the effects of such a change in fiscal policy should be most carefully studied and a well informed opinion on the question, evolved.

Let us look at the request from an English standpoint and ascertain what would happen if the Indian market, as it now exists, was partially closed to English manufacturers. English exports to India are valued at more than 50 millions a year and are roughly two-thirds of the total imports into India and are about one-sixth of the total exports of the United Kingdom. We may certainly assume that the tariffs would be framed so as to afford marked preferential treatment to the products of the British Empire and trade now done with foreign countries would be diverted to the United Kingdom. The object of protection would be to make India more self-supporting in the matter of manufactures and this would necessarily involve the development of the internal, at the expense of the external trade. The English manufacturers would certainly lose a good deal of business and protection would be a serious blow to the cotton, iron and shipping trades. That they would ultimately recover, there is not much doubt, but it is useless to discuss this phase of the question in detail, as it is not what England would lose, so much as what India would gain, that has to be established by those who advocate a protective policy for India.

If there were any reasonable prospect that the adoption of a protective policy would be followed by a rapid development of Indian industries on a purely indigenous basis; that is to say, with Indian capital and through the agency of Indian brains, there would be some grounds for asking for the concession, as it would not then be

in spite of the mistakes and ignorance of the pioneers in this movement; the former will be remedied and the latter dissipated as experience is acquired. The weavers themselves are so backward that the attempts to get them to co-operate have not been successful; nevertheless the small factories will probably do well when the technical questions connected with their equipment have been solved. What we may look forward to in the future are groups of from fifty to two hundred weavers centred round a warping and dressing plant. This will supply warps to the weavers, who may either be collected in a shed or will work in their own homes. The trade will be in the hands of those who run the warping plant and on them will mainly fall the work of introducing improved looms and methods among the hand weavers. Though trades unionism is undeveloped in India, the passive resistance of the weavers to any change is a serious factor which those experienced in the ways of the artisan will not lightly ignore. The part which Government should play in this movement is to supply the skilled technical knowledge required to devise the equipment and when that step has been taken to start demonstration factories and trade schools for the instruction of those who want to become foremen and master weavers.

Metal-Working.—The metal-workers of India are skilled craftsmen working with very crude and imperfect tools and possessing little or no technical knowledge. Some years ago aluminium was introduced into the metal-working class at the Schools of Arts at Madras and a large business created in hollow-ware made of that metal. This was eventually disposed of by sale to a private company, which still continues to deal exclusively in such goods. The processes of drawing and spinning were employed for the first time in Southern India

and a large number of workmen trained ; unfortunately the factory is now a purely private concern and has little influence on the practices of the artisans outside. Similar factories have however been started in Bombay, and at Rajahmundry in the Godaverry District of the Madras Presidency there has sprung up in recent years a large and thriving community of metal workers who deal solely in Aluminium. The total trade in India in this metal is now worth many lakhs of rupees and every year it is growing larger. Ultimately it is possible that the metal itself will be manufactured in the country as there are abundant deposits of laterite, consisting of almost pure hydrate of alumina from which alumina can be extracted pure enough for treatment in the electrolytic furnaces. This industry is a striking example of what may be accomplished by Government initiative.

The teaching of metal-working processes can only be done in a factory and anything similar to the aluminium venture is not likely to be attempted again, in view of the opposition which is aroused when any State or State-aided institution adopts commercial methods for the disposal of the finished products which must be made to furnish sufficient opportunity for the acquisition of skill and experience. Glass, earthenware and enamelled iron-ware have made serious inroads in the trade of the brass and copper workers and there is but little hope that the loss can be made good. The increasing wealth of the country to some extent counteracts the tendency to introduce cheap substitutes for the ancient metal wares ; this tendency might be greatly assisted if the metal-workers were taught to turn out lighter and better finished work. That this could be done there is no doubt, and a trade school in one of the big metal-work centres, with a staff of competent teachers in each branch of the trade, is the only

way in which the desired end can be attained. The workshops should be furnished with good tools and the metal-workers encouraged to come and use them for their own work. Gradually they would discover the value of such appliances and it would not be long before they found a way of getting them for themselves. Very small factories are already common in the trade and the lines along which development will naturally take place are clearly indicated.

Artistic Handicrafts.—The art industries of India have declined chiefly because the wealthy Indian patrons have disappeared and all that is wanted to revive them is an appreciative market. There are signs that the frequent exhibitions now held in various parts of India have done something to create a new interest in these old arts and it is probable that the Swadeshi movement has strengthened it. In Madras, the Victoria Memorial has taken the form of a hall in which a permanent exhibition of the art handicrafts of the Presidency is maintained. A large fund is available for the purchase of good specimens of the various crafts; when these are sold new commissions are given and a much-needed stimulus to the production of only the best work provided. It is too early to say what the ultimate result of this novel method of dealing with the decadence will be, as it has not yet developed to its full extent; there is justification for the hope that it will be a success. The collections are steadily increasing in size and in artistic merit and attract purchasers, who will buy a thing they can see and which they admire but who formerly would not give orders because there was no certainty either as to the date on which they would be completed or as to the quality of the work put into them.

Tools and Machinery.—The manufacturing engineers and mechanicians have devoted themselves mainly to the

design and production of machinery as automatic as possible in its action and with as large an out-turn as possible. This tendency has encouraged industrial concentration. In India all work is done by manual labour or with the assistance of cattle; water power is only available and to but a limited extent in the hills; wind power has never been used, as over the greater part of the country the energy of the winds is too slight and of too variable a character to be of any value. The oil engine, when of small size, is much more economical than a steam engine of the same size; it costs less and is much simpler to look after. For these reasons it has to some extent come into use in India and will probably be very largely used in the future. The ideal engine would be a small gas engine working with gas made from wood. Already engines of not more than nine horse-power with suction gas producers using charcoal are employed; something much smaller than this is wanted and if wood can be substituted for charcoal it will greatly reduce the working expenses. There are many hundreds of oil engines in use and there will, in course of time, be many thousands. There is therefore a fair inducement to engineers to study Indian requirements, as every improvement will extend the range of their employment. It is the very rapid progress that has been made with internal combustion engines that has raised hopes that India may gradually acquire an industrial system based on small units of production and that is all the more likely to come about if the attention of the engineering world is drawn to this fact. Each industry and every branch of it should be the subject of investigation to ascertain the lines along which motive power may with advantage be introduced. The water-lifting question has already been discussed and need not be further alluded to. This is the largest field for the immediate applica-

tion of power but there are several others of great importance which have been opened out, in which a great deal more could be done if the machinery on the market were better adapted to the work to be carried out.

(1) Sugar Mills.—For the crushing of sugarcane, roller mills are now in use in many places and are driven by oil engines. The results are very satisfactory where there is a sufficient area of cane in the immediate neighbourhood of the mill to keep it at work throughout the season. From 50 to 100 acres of cane could be dealt with by a single mill ; but as such areas are seldom cultivated by a single ryot, co-operative working is the only way by which this use can be largely extended. Growing sugar is a very profitable business but it requires capital and is subject to risks. Heavy manuring is a necessity and with cattle-driven mills the crushing of the canes is a long and tedious operation. Consequently, ryots usually only grow a small patch of cane. The extended use of artificial manures and of power-driven mills would probably result in a very considerable increase in the production of sugar and would tend to check the very rapid growth of imports.

(2) Oil Mills.—Oil is usually extracted in wooden rotary mills, of a very primitive type worked by cattle, or in large screw presses worked by men. Both systems are naturally expensive ; attempts have been and are still being made to apply oil engines to do the work. The mill or press has yet to be designed which will displace those now in use. The home consumption of oil in India is very considerable and it only requires the application of some of the ingenuity which has been devoted to large extraction plants to the production of a small plant which can be driven by a small engine to effect a considerable saving in the cost of producing a prime

necessity of life. Oil seeds are very widely grown and as the primitive methods of extraction easily hold their own against the big mills, the improvement of the small mills and the substitution of oil engines for animal power in driving them is obviously the direction in which to work. If the problem be solved, the demand for such mills will be very large, as the labour costs are now very heavy and for years past have been steadily rising.

(3) *Rice Hulling Machines*.—Till recently almost all the rice consumed in India was cleaned by hand, only that portion of the crop which was exported being treated in mills driven by power. There are now a number of rice-hullers on the market, suited to the restricted scale on which village rice merchants deal, and in the rice growing tracts of the Madras Presidency they are largely used. An oil engine of from ten to twelve horse power is employed to drive a combined huller and polisher which turns out from 2500 to 3000 lbs. of clean rice a day. There is a demand for machines of even smaller capacity than this as many ryots, who have an engine and pump, would like to employ the engine to drive either an oil mill or a rice-huller when there is no necessity to lift water for irrigation.

(4) *Saw Mills*.—There are but few steam saw mills in the country, nearly all the timber being reduced to scantlings by hand-cutting. Not only is the cost of labour for such work high but there is also a considerable waste of wood, owing to the irregularity of hand-sawing. Circular saws or large band saws require too much power but a simple type of frame saw, with a single blade, can be constructed to do a great variety of work and take not more than three or four horse-power. There is sufficient work for a plant on this scale in almost every town in the country and it only requires that the advantages, to be

obtained from their employment, should be demonstrated for a demand for them to spring up.

(5) *Fibre-Cleaning Machinery*.—The cost of extracting fibres, even with the cheap labour available for such work, is very high and improvements in the machines already in existence are urgently called for, especially for aloe and plantain fibres. These machines should be of small capacity, as the quantity of raw material from which the fibre is extracted is not usually very large in any one place and the cost of carting it from a distance is prohibitive.

(6) *Dyeing*.—The old native methods of dyeing have been almost entirely replaced by those dependant upon the use of chemically prepared dye stuffs. In some parts of the country, as at Madura, the industry is in a flourishing state and the processes employed are fairly satisfactory but generally throughout India there is an entire lack of technical knowledge of what dyes are best suited for the work to be done and of the methods which should be used to obtain good results. This can only be remedied by the establishment of a Government Tinctorial laboratory and school, where those engaged in the trade can obtain expert advice and instruction. This question is now engaging our attention in Madras and proposals are under consideration for the establishment of such an institution.

It is not necessary to give further examples of the opportunities for the display of mechanical ingenuity in meeting the requirements of the people of India. The object of this paper will be to a large extent gained if attention be directed by it to the field which is open to original workers; further inquiry will probably reveal a large number of instances in which a comparatively small amount of capital expended on tools and plant would

greatly increase the efficiency of Indian labour. At the outset, progress will be slow, chiefly because of the difficulty of bringing the men with sufficient inventive skill into touch with the rural communities whose wants have to be studied. India now requires the services of many industrial experts and it should be recognised that adequate rewards must be offered to those who will take up Indian industrial problems. In technical colleges, in trade schools and in demonstration workshops, the science and engineering skill of the West must be applied to the peculiar industrial problems which call for solution. Scientific research having no other object than that of enlarging the bounds of human knowledge is a luxury which India cannot at present afford to indulge in, nor does it greatly attract the Indian mind. Scientific methods have first to be taught in the country and applied to the practical problem of raising the industrial status of the people. This work affords as much opportunity for the exercise of intellectual attainments as will be found in any laboratory and it is that to which men in the service of India must devote themselves if they are to render her real assistance.

difficult to show that the development of the wealth of India would be followed by an ultimate expansion of the external trade of the country. The character of the trade would undoubtedly be changed and it would cause dislocation of business and loss of capital in England, but in the long run it would be recouped by new developments. There is, however, no hope that this would ensue and alike in the interests of India and England, the demand for protection can be shown to be ill-timed and injudicious.

The Indian case for protection was first clearly stated by the late Mr. Justice Ranade in 1892 and his words have been so often quoted and are so familiar to all students of Indian economics that it is unnecessary for me to trouble you with them again. I may, however, be permitted to refer to the presidential address of the Hon'ble Mr. R. N. Muckerjee delivered to the Allahabad Industrial Conference at the end of last year. Discussing the effect of foreign competition on the infantile attempts at industrial development which have been made in recent years, he said "This "is a most serious question and not only this Conference "but every man of this country should continue to con- "stitutionally agitate until Government affords protection "in some shape or other to local manufactures. We all "know that if the Government of India were left alone to "do its duty towards India, there would be no hesitation "in introducing some such measure suitable to the special "needs of India. But there are stronger influences at "work whose interests clash with our own, and without "the combined efforts of the Government and the people, "I am afraid, we shall never get a satisfactory solution. "The question of protection is, I admit, a complicated "and serious one and it is with a great deal of hesitation and "diffidence that I refer to it at all, but it is a question that "should be most carefully considered, as otherwise to do

" good to some of our industries, we may court disaster "in other branches of commerce. I would suggest that the "Government should be approached and asked to appoint "a joint commission of officials and commercial men, to "discuss and decide in what particular form protection "would be most beneficial to India. This point should "be definitely decided before we actually apply for any "protective legislation. I think it is imperative on our "leaders to give this question their first consideration and, "if we are successful in securing a wise form of protection, "I am sure the country's industrial development will re- "ceive a great impetus."

This, we must all admit, is a very moderate expression of opinion upon a subject which neither in this country nor in any other, is usually discussed with judicial calmness and in temperate language. I am prepared to concede that, if India were allowed to adopt a strong protective policy and persisted in maintaining it for a long period of time, the result would be a very considerable amount of industrial progress along western lines, but I doubt very much if the result would be pleasing to the people of India or would enable them to satisfactorily solve the problem of unemployment among the educated classes which is every year becoming a more serious one.

There is much loose talk about the vast natural wealth of India, but it will not bear close examination. The area is large, but only in certain favoured tracts, does the soil yield a good return without the stimulus of artificial irrigation. The population is enormous, but their standard of living is extremely low and there is little surplus for what may be termed the luxuries of life. It would, I think, be extremely difficult to point to undeveloped resources which any system of protection would assist the people to make practical use of. In normal

years, when the terrible spectre of famine is absent from the land, there is no lack of employment and, in fact, all over the country, there is a general complaint that the quantity of labour available is insufficient to carry on the current work. The great mass of the population are not crying for industrial development, they have already as much work as they want and there is but little common sense in trying to divert the labourers from the field, to work in mills and factories and live in crowded and insanitary cities.

As to the people themselves for whom protection is demanded whilst they set about building up an industrial system, let me quote the opinions of accepted Indian authorities as to their fitness to undertake the work. In regard to the condition of labour in the country, Professor V. G. Kale of the Ferguson College, Poona, writes: " We have " scarcely yet emerged from our primitive conditions of " industry. Custom yet rules supreme among the masses " of our people. Old industries are still in the domestic " stage. We are strangers to capitalism. Indian manu- " factories are in the embryo or sickly infants. Millions are " wedded to their fields and have to emerge out of their " agricultural state; large cities and towns are exceptions, " and hamlets and villages the rule, the masses are illiterate " and immobile; labour is unskilled and inefficient, unam- " bitious and unenterprising ; capital is lacking and shy " where it exists; organisation is unknown to both. Under " these circumstances, for us the industrial struggle on " western lines is a thing of the future, if it cannot be " avoided. The conditions which make for industrialism " are yet absent in this country. Not that there is no " poverty and squalor, destitution and misery among us. " We have enough of these. "

Of the educated middle classes, in his presidential

address already referred to Mr. Muckerjee said : " There " is no lack of so-called enthusiasm, but I may be par- " doned, if I say it is only lip enthusiasm on the part of " many of our countrymen. There are many who are " loud in their praises of Swadeshism and the revival of " Indian industries, but their patriotism is not equal to " the practical test of assisting in the finance of such enter- " prises. "

There is already much industrial enterprise in India which is absolutely beyond the effects of foreign competition. Nevertheless it is almost entirely in the hands of people not born in the country. Let me give full credit to the enterprise which has developed the mill industry of Bombay, which is pioneering the manufacture of steel and iron in India and which is capable of bringing to a practical issue the great hydro-electric scheme which will supply Bombay with light and power. These examples illustrate in a remarkable way the developments possible when Indian capital and European experience and technical skill are associated in harmonious co-operation. With these exceptions, modern organised enterprise throughout the country is almost entirely of European origin. There is no time to discuss them in detail, but I would like to ask you to consider the comparatively small share which India has taken in the development of her magnificent railway system, in the establishment of municipal tramways or in the provision of artificial illumination, either by means of gas or electricity. To what extent is the great jute industry in Indian hands or how far is the not inconsiderable development of India's mineral resources due to the application of native capital ? Are there any engineering workshops other than petty foundries, run with Indian capital and controlled by Indian engineers ? There is much work going on in such

shops which is absolutely unaffected by foreign competition. Even in modern agricultural developments, as represented by the planting industries connected with tea, coffee and rubber, the Indian share is almost negligible and it is quite certain that they would not have come into existence if it had been left to indigenous enterprise to develop them.

The cry is for the protection of infant industries, but the history of the past leads me to think that if protection were granted, the enterprising foreigner would be the person to take advantage of it and the state of things in every industry would be very much like that so graphically described by the Hon'ble Rao Bahadur R. N. Mudholkar in his presidential address at the Industrial Conference which was held in Madras a little more than two years ago. Speaking of the working of gold mines, he said ; " The industry, however, is looked at with considerable shaking of the head and regarded as a typical illustration of foreign exploitation. Not one of the mining companies is Indian. The total value of gold raised during the quarter of a century that the Kolar Gold Fields have been at work is roughly 40 crores. Out of this only 1--19th or a little over two crores represents royalty, and nearly 50% has been distributed among the shareholders as dividend. The benefit to the people consisted only in the wages to labourers and clerks. There is neither the pecuniary gain from proprietorship nor the valuable moral asset of training and experience in the scientific operations and in the directing and controlling work." And further on in his address, he comes to the conclusion that it is high time that action is taken by the people which would, if not put a stop to, at least minimise exploitation by outsiders.

What I would submit for your consideration is that even if protection were desirable, you are not ready for it.

There is no fund of capital seeking remunerative investments. Industrial leaders with technical skill and business experience are non-existent and the operative labour could only be obtained with difficulty and would require training from the very beginning. You might exclude British manufactures, but you cannot exclude the British manufacturer. A protective tariff would compel him to start in India and stimulated by the inflated prices which he would be able to obtain within the protected zone, there can be but little doubt that with his energy and business experience he would overcome the initial difficulties due to lack of local knowledge. Managers, foremen and workmen would be sent out to India, native labour would be trained and mills, workshops and factories set going. All posts of responsibility would be in European hands. India would have an industrial system, but it would be no source of profit to her and it would certainly not furnish the educated classes with occupations of a superior character, the need of which has led them to cry out for industrial development. It has been argued that this would be so at first, but that gradually the Indian would *wend* his way in and oust the European. If this were likely to happen it might be worth while paying the price to get the initial work done, but there is very little evidence that such would be the result.

The poverty of India is largely due to the fact that the people themselves are content with an extremely low standard of living and are averse to more exertion than is required to provide themselves with what is generally little more than the bare necessities of life. The material development of the country under the stimulus of a progressive administration has proceeded at a much more rapid rate than the elevation of the people from their primitive conditions of life, and we now witness the strange spec-

tacle of one of the poorest countries in the world exchanging its surplus produce for, to them, useless precious metals. On an average the hoards of gold and silver in India are increased each year by 20 millions sterling. A country which chooses to bury so much wealth every year must be still unenlightened and lacking in enterprise. India wants education rather than protection, and the most useful service that Indian politicians and statesmen can render to their country is to devise means whereby some considerable portion of the funds now uselessly hoarded can be expended on the education of the people. The unemployed educated classes might then find full employment in the education of the vast masses of their countrymen who are still plunged in intellectual darkness.

India does not want a protective tariff to enable an artificial industrial system to be created, the masters of which will be able to take toll of the earnings of the country and establish a drain on its resources which will in the long run retard progress and produce much misery and discontent. It would be safe to say that for the development of the internal agricultural resources of India fully 200 millions of capital could be usefully employed and while there is such a vast outlet for directive energy and surplus wealth it seems futile to endeavour to establish an industrial system foreign to the habit of the people and inimical to their best interests. The cry for protection is, I hold, a mistaken attempt to force the country into a course of action for which it has but few natural facilities and for which its people possess little inclination or aptitude. The land is fully occupied, but only half developed, and there is ample scope for constructive statesmanship of the highest order in dealing with the innumerable problems in connection therewith which present

themselves for solution. Work along these lines is in progress and hearty co-operation on the part of the leaders of the people with the Government is necessary and will better serve the interests of India than a hopeless agitation for a change in fiscal policy which in the long run is likely to prove an intolerable burden.

The work I am now engaged upon brings me frequently into contact with some of the most enterprising and capable land owners and ryots in this Presidency and I have formed the opinion that what they have been able to do on a limited scale might be extended indefinitely, if suitable measures are taken to spread education, encourage thrift and assist enterprise. The great weakness of the situation is due to the small scale upon which such work is carried on and the great hope of the future lies in the development of co-operation. At present it is a plant of tender growth and requires careful nurture. The reports of the Registrars of Co-operative Credit Societies in India display a healthy optimism. The advantages of the system are beginning to be appreciated by the cultivators and there seems to be no doubt that in course of time this method of strengthening their resources will become as firmly established in India as in the European countries where it originated. Co-operative credit is the first step towards co-operative enterprise and it is in this direction that we must look for the solution of many difficult agricultural problems due to the smallness of individual holdings. As an example of what may be achieved in this direction, I should like to bring to your notice what has been done in the village of Atmakur in the Kistna District. This village is situated near the Kistna Western Delta main canal. Throughout the irrigation season, the fertilising waters of the canal have for more than half a century flowed by, with-

out any possibility of utilising them owing to the high level of the land. Three years ago, the villagers formed themselves into a limited liability company and with the assistance of some capitalists in Guntur, raised sufficient money to establish a pumping station on the banks of the canal. At a cost of Rs. 14,000 two centrifugal pumps were installed and last year 465 acres of what was formerly practically waste land were cultivated and crops obtained, worth Rs. 22,500. These villagers have now determined to extend the area under cultivation to 800 acres and have raised funds to enable them to double the capacity of their present pumping plant. They pay the full water rate levied on the lands irrigated by the Kistna Delta Canals and, in addition, the cost of pumping which amounts to something like Rs. 10 per acre, and then they have a satisfactory profit. Each year the fertilizing silt of the canal water is improving the quality of their lands and the annual value of the crops raised will soon exceed half a lakh of rupees. The success in this case is noteworthy and cannot be too widely made known as an incentive to others to go and do likewise.

In the improvement of the natural capabilities of the soil and in the preparation for the market of its varied produce, there is a sufficient field for the absorption of all the enterprise that is likely to be available within such period of time as it will be wise for us to take stock of. Let us consider for a moment the great sugar industry which has fallen on evil days and is said to be threatened with extinction by foreign competition. I am not an expert in any branch of the business, but it has fallen to my lot to help landowners to instal machinery for dealing with the cane after it is cut, and of necessity, I could not help acquiring some information regarding

the conditions of the industry in the Madras Presidency. With us it is not a very important crop as the area under cultivation amounts to only 50 or 60 thousand acres, but it is a very valuable crop and the average gross yield may be put at somewhere about Rs. 400 an acre. Moreover, notwithstanding foreign competition, it is yielding a net return under favourable circumstances of not less than Rs. 200 per acre. With annual imports now amounting to eleven crores of rupees a year, there is room for expansion and it is certainly desirable that we should know with great accuracy the reasons which militate against the extension of the area under cultivation. Tentatively I would put forward the following :—

(1) Lack of capital to cultivate a crop which requires heavy manuring and much attention, and from which a return can only be expected a year after the cultivation commences. The development of co-operative credit will undoubtedly place the would-be cultivator of sugar-cane in a better position to obtain loans, but it should be possible to devise more direct means to finance this crop and the establishment of sugar banks is indicated.

(2) The primitive and wasteful processes of extracting the juice and converting it into jaggery or raw sugar. Co-operative enterprise will remedy this to a large extent and I have frequently advocated the establishment of small power driven mills as the first step towards the provision of subsidiary factories for the manufacture of raw sugar, to be subsequently refined if it should be necessary in large central establishments equipped with modern plant.

(3) The risks from pest, blight and disease to which the canes are subject and which the ordinary cultivator is powerless to deal with. The success with which the Agricultural Department has combated such troubles in

the Godaveri district is evidence that, if these cannot be altogether overcome, they may be greatly minimised.

(4) The lack of water for irrigation in certain seasons of the year. The extension of the use of mechanical methods of lifting water will remedy this, and I may mention that at the present time we are putting down a number of oil-engines and pumps to lift water about 50 feet for the cultivation of sugar-cane and the cost of doing so will be less than one-fourth what it would be if an attempt were made to use cattle power to effect the same object. Much also, I think, might be done by the Irrigation Department to provide perennial sources of water-supply and I will only instance the possibility of growing something like 30,000 acres of sugar-cane under the Periyar Project in the Madura district, if water were reserved for that purpose. I might mention incidentally that it would also permit of the generation of 20,000 H. P. which could be usefully employed in developing the industries of the district.

(5) The ignorance and apathy of the ryots and their aversion to cultivating new crops, of which they have had no previous experience. The spread of education, the force of example and the appointment of experienced local officers to render assistance will, each in their way, contribute to removing this difficulty.

Protection has already been specially asked for in the case of this industry, but where enterprising ryots are making large profits by growing sugar-cane it is obvious that it is not protection that is the remedy, but, the vigorous exploitation of the industry on a well considered scientific plan.

It is unnecessary for me to allude in any detail to the work we are now carrying on in connection with the improvement of the methods of lifting water and in

the development of under ground sources of water-supply. India spends fully 40 crores a year in raising water for the cultivation of some 16 million acres of land and whilst the area of such cultivation is probably capable of being doubled, there is no doubt that the cost of raising the water can be greatly decreased. In this direction we have made a very good start in Madras and we are already beginning to manufacture locally the pumps which it has hitherto been necessary to import and I look forward at no very distant date to the establishment of works which will be able to manufacture the whole of the plant we require. In this field there is room for the employment of much capital which will yield far better returns than can possibly be expected from sickly industries owing their precarious existence to an artificial system of protection.

We have heard not a little, of late, of the dangers of state interference with private enterprise, but I should like to point out that protection is the most aggravated form of state interference that can possibly be devised. I am of opinion that a little paternal assistance of a direct character, the cost of which can be accurately determined and the operations, which are carried on, definitely limited, is a more logical and businesslike method of dealing with the industrial question than subjecting the whole country to a system of tariffs which will increase the cost of living and divert energy from its natural channels into artificial courses, most probably not leading to the best utilization of the resources at our disposal.

Protection is claimed to have done much for the United States and Germany, but it is difficult to assign to each of the contributing factors to the marvellous progress of these countries its exact share in the final result. I am inclined to think that undue prominence has been given to the fiscal effect and that it would have altogether failed, had

there not been behind the tariff walls, an energetic and instructed people, eager and anxious to improve their material condition. It is certain that in India we altogether lack this essential to success and though a protective policy may enable us to establish an industrial system under foreign control, it will with equal certainty hamper our national development and will, in homely phrase, prove to be a leap from the frying pan into the fire.

CHAPTER III

THE EFFECT OF PROTECTIVE TARIFFS

I

In 1892, at the Deccan College, Poona, the late Mr. Justice Ranade delivered an address on Indian Political Economy, which has since been generally accepted as a clear exposition of the Indian case for State intervention to promote a healthy state of industrial development. He claimed that, in a backward country like India, a well-considered system of import duties would afford that measure of protection which is essential to industries, but, recognising the improbability in those days of any change of the fiscal policy of the British Empire, he went on to say : "Even if political considerations forbid independent action in the matter of differential duties, the pioneering of new enterprises is a duty which the Government might more systematically undertake with advantage." Ranade's ideas have gradually permeated both European and Indian economic thought in India, and to-day a protective policy is recognised throughout the country as being urgently called for, if the industrial condition is to be adjusted to the growing needs of the population.

Famine Commissions have emphasised the necessity for varied occupations for the working classes, and of late years, it has become abundantly evident that new outlets must be found for the energies of the ever increasing output of our modern system of education. Recog-

nised avenues to wealth or competency are already over-crowded and many fail to find adequate material return for the trouble and expense which a good education entails upon their relatives. Work for these people can only be found in an extensive development of industrial life, and it is but natural that the movement in favour of a protective tariff should, year by year, grow stronger. None seem to doubt that, if India were granted fiscal autonomy and able to create a tariff to suit its own requirements, the desired industrial development would be brought about.

Such has undoubtedly been the effect of protective tariffs in America, Germany, Austria, Northern Italy and to some extent in Russia, but it can hardly be said that in the Latin Kingdoms of Europe, in South America or in the British Colonies in the Southern hemisphere, protective tariffs have had any great measure of success. It therefore seems worth while to examine the circumstances of India, and to endeavour to apply to Indian conditions the results of experience with tariffs in other parts of the world. Judging by the countries where protective tariffs have undoubtedly proved an enormous stimulus to industrial development, success has been achieved, because intelligence, skill, capital and natural resources were all available. Failure may be due, as in the case of the British Colonies, to the smallness of the home market and the high cost of labour; or as elsewhere, to the lack of initiative and enterprise on the part of the people.

An industrial survey of India reveals a flourishing cotton industry, mainly in native hands, a flourishing jute industry, almost entirely controlled by Europeans, and a few scattered factories devoted to miscellaneous trades, the more important of which are of European origin. In this connection, we may neglect Government workshops which are not commercial concerns and railway workshops

which are mainly devoted to the maintenance and repair of the material and rolling stock of the lines to which they belong. Besides these, there is a great indigenous industry of a very varied character, not entirely uninfluenced by modern progress, but suffering from lack of organisation and adherence to primitive methods of work. The artisans, who carry on these trades, are ignorant and uneducated, and the bulk of their profits are absorbed by the local merchants and sowcars who finance them. India imports manufactured goods and pays for them by the export of raw agricultural products, and year by year, it is parting with increasing quantities of all of the elements which go to make up a fertile soil. Whether the supply is inexhaustible, or not, cannot now be considered; but, obviously, it is desirable that in these matters it should be in a less dependent condition. The progress of India has been estimated, in a not altogether satisfactory manner, by the rapid growth of its external trade, and it is commonly held by Indian writers on economic subjects that the local industries have been very adversely affected by the growth of foreign trade. The evidence on which this contention is based is, however, of a very slender character, and, at some convenient time, it would be interesting to examine it carefully. Probably equally fallacious is the idea, largely held in England, that the industrial development of this country would lead to a diminution in the volume of its business with Europe. Almost certainly, it would be otherwise. The character of the trade might, to some extent, change, but the greater diversity of occupations in India would lead to a greater production of wealth, to a general rise in the standard of living and to the creation of many wants which could only be supplied by foreign trade.

Now most of the continental countries and America have made use of protective tariffs to exclude British manufac-

tures and they have to a large extent succeeded, but they have not been equally successful in getting rid of the British manufacturer. Many English firms, rather than relinquish their trade, have sent part of their capital abroad and have established branch factories in foreign countries. Notably has this been the case in America and to a less extent in Russia, Austria and Italy. In England, we have a similar example of the effect of the legislative enactments on foreign trade. The recent reform of the patent laws has compelled foreign firms to establish factories in England in which to work their English patents and no inconsiderable amount of foreign capital has recently been expended for this purpose, with the result that a large amount of employment has been found for British working men and a larger market created for local supplies of raw material.

Bearing in mind these facts, let us try to imagine what would probably happen in India if a tariff be placed on imports, not for the purpose of raising a revenue but to stimulate industrial enterprise. The prices of all the protected articles would rise by the amount of the duty, and either they would be manufactured in the country or they would continue to be imported. In the latter case, the revenue would be swelled and the people using the imported goods would be taxed by the amount of the duty plus the cost of financing the duty on the goods from the time they were taken out of bond till they passed into the hands of the consumer. The rise in prices would act adversely to trade and in almost every case, it is certain that the demand would fall off. Manufacturers abroad would then consider whether or not it would be worth their while to make an effort to keep the trade for themselves by establishing works in the country. Unquestionably, their keen commercial instincts would compel them to send their

capital to India and there would be a great outburst of industrial activity. Managers, heads of departments, foremen, and even in some cases workmen would be sent out here. Factories would be started, business connections established and India would embark on an industrial course, but not exactly on the lines that Indian advocates of protection desire. Employment would be found for thousands and tens of thousands of artisans, coolies, clerks and lower grade subordinates, but there would be little room in these factories for Indian brains and intelligence, and few opportunities would be afforded to the young men of this country to obtain that intimate knowledge of manufacturing processes and business organisation which is essential to the successful conduct of modern industrial enterprise.

Assuming that the protective duties are made sufficiently high, these industrial undertakings would be profitable, but the profits would not add much to the wealth of Indians. It would be largely in foreign hands and a considerable proportion would leave the country. This would be a small matter if, in course of time, the skill and experience necessary to manage these undertakings were gradually acquired by Indians, but that unfortunately is hardly likely to happen and the introduction of a protective system in India would probably result in a serious drain upon its resources, such as a country experiences when it suffers from absentee landlordism.

Against all this, it may be urged that with a protective tariff Indian capital would seek industrial outlets, that Indian brains would manage and control industrial undertakings and that Indians, with their superior knowledge of the country and the people, would be able to successfully compete against the foreigner with his more extended experience and inherited aptitude for business organisation.

In proof of this, the cotton industry would certainly be cited and Indians would point with pride to the industrial enterprises of the citizens of Bombay, to men like the Tatas, the Petits, to Sir Vithaldas D. Thackersey, Sir Currimbhoy Ebrahim, Sir Adamjee Peerbhoy and many others. Yet it is a singular fact that it is only in this one part of India and only in the cotton trade that Indians have so far held their own.

I must confess I cannot satisfactorily explain why Parsis and Indians have obtained a commanding position in the cotton trade, and I do not overlook the fact that great efforts are now being put forth to establish an iron industry with Indian capital in India, or that a great scheme for the electric generation and distribution of power in Bombay is being started. These are great enterprises and would be considered as such, not merely in India, but in any part of the world. They are, however, not yet at work and at present they can only be reckoned as probable achievements of the future. Further, it must not be forgotten that whatever measure of success is reached, the result will be due to the foreign technical experts as much as to the Indian financiers who have boldly ventured their capital. The condition of things in Bombay is exceptional and only serves to show that even under the present free trade regime, where enterprise and initiative are forthcoming, progress is possible and a healthy industrial life has been evolved without the assistance of tariffs. Elsewhere in India we look in vain for similar signs of industrial enterprise, though in a more humble way a good deal of activity has been displayed in recent years and efforts are now being made which in time will undoubtedly fructify.

The truth is, and to the Indian imbued with the swadeshi spirit it must be somewhat unpalatable, that the people of this country are not yet prepared to embark on

great industrial undertakings, to manage large concerns, and generally to take advantage of a protective system of tariffs such as has been imposed in other countries with such definite results. The sooner this is recognised, the sooner will the cry for protection cease and attention will be concentrated upon the only lines along which development is possible.

Protection in India will only come with fiscal autonomy and that must be regarded by practical people as a dream of the distant future. The free trade policy which England has adopted for the last 60 years may be reversed, but if so it will be in favour of free trade within the empire and protection against the foreigner. This is the utmost measure of protection that India can look forward to so long as it remains an integral part of the British Empire. So long as India needs British help, guidance and protection, so long must it accept the present system of financial control and be satisfied with the fiscal policy of the Central Government. It cannot enjoy these advantages and at the same time shut its gates to the free admission of the products of the other Federated States of the Empire. This being so, it would be well to pursue inquiries in the direction I have indicated and endeavour to ascertain what would be the probable consequences of India being allowed to adopt a protective tariff.

Briefly, in my opinion protection would impose a heavy burden upon India and the benefits of the system would be largely reaped by others than the people of this country. Indian labour would of course find a new field for employment, but that is a doubtful advantage as till such labour is trained to be more efficient, India has in normal times no surplus. At best it would promote but a mushroom growth founded on tariffs and sustained by artificially high prices. This is not the goal so highly desired by

progressive Indians and if these views on critical examination are found worthy of acceptance, they may help to remove an element of discontent with the present *regime* as being without a sound basis of facts.

II

If one may judge by the result of the General Election just concluded, there is very little prospect of any change in the Fiscal policy of the British Isles in the immediate future, but even if in this I am wrong, the most that India can hope for from the Tariff Reform Party will be authority to differentiate between imports from the British Empire and imports from the rest of the world. As an aid to establishing industries in India this would be of slight value as three-fourths of the imports of India now come from the United Kingdom and the Colonies and the protective tariff we may assume would be sufficiently high to exclude foreign manufactures almost entirely. From the Indian point of view, it therefore matters little whether Tariff Reform be accepted by the United Kingdom or not. Indians are discontented with the existing Policy and would be equally discontented with that which may, or may not be, introduced in the future. The question at issue is whether that discontent is based upon a real grievance or whether it is founded upon an inability to appreciate the present position. I regard it as a matter of great importance that there should be no imaginary causes of discontent against British rule in India as the future welfare, both of India and the rest of the British Empire, depends in no small degree upon the fact that the people of India are being treated, and recognise that they are being treated, with justice and consideration by the paramount power and that everything is being done by a paternal Government to foster loyalty and contentment.

My main contention is that protective duties whilst effective to exclude British manufactures and thus afford infant industries an opportunity to take root in this country will not exclude either British capital or the British manufacturer. Let us assume that the cotton trade is effectively protected and that imports from Lancashire are partially excluded. It will very materially affect the mills of Lancashire and manufacturers, engineers and capitalists will immediately transfer their energies, their experience and their money to Western India and the Bombay mill owner will be faced with energetic and determined rivals setting up in business alongside him. There will be competition for Indian labour but the enhanced prices will pay for that, and the people of the country in their millions will pay the enhanced prices for cotton goods. Who will benefit—the mill operatives undoubtedly—the successful manufacturers certainly, but who will constitute that class? It is difficult to say. The Bombay mill owner may hold his own but it is possible that in a few years he will succumb and like the dog in *Æsop's* fable he may drop the substance in trying to grasp the shadow. I believe in the industrial future of India, but I hope for the sake of the country that it will be of natural growth and not a hot house plant forced into existence by the application of an unhealthy stimulus.

The cotton spinner prefers to work in England and export his manufactures but if you exclude his goods, he will come over here and start making them in the country. I have no wish to depreciate in any way the energy, skill and enterprise displayed by the Indian Mill owners but I gravely doubt if they are as yet the equals of the Lancashire men and I feel certain that they will be wise to leave well alone.

The effect of protective duties is to give the protected

country a monopoly of its own market. Now every country enjoys a certain amount of natural protection and India is no exception to the rule. What has happened to the naturally protected industries of India will serve at least as an indication as to what is likely to happen if an artificial system of protection is introduced by the imposition of import duties. As examples of different types of naturally protected industries I submit the following list:— (1) Railway repair workshops, (2) Local iron works, (3) The jute industry, (4) Tea, (5) Rubber, (6) Coal mining, (7) Petroleum industry, (8) Gold mining. Let us examine these in detail, but before doing so, it will be convenient to state that in every one of them the European is supreme and the Indian nowhere. It is true that in some he may have invested capital and in a few Companies Indians will be found on the Boards of directors, but broadly stated the management and control of those industries are in foreign hands and, if it be so with these industries, it is at least likely that it will be so with industries artificially protected.

Railway repair workshops.—Every Indian Railway has large workshops for the repair of its rolling stock and for the partial construction of waggons, carriages and, in some cases, locomotives. It is from the very nature of the work completely protected but the capital of the Railways is mainly held in Europe and the management and control are entirely in European hands. This is no doubt a very special case, but with every inducement to economy it has not been found practicable to employ Indians in any but comparatively subordinate appointments. Even in Native States the Railways and their workshops are not under the control of Indian experts.

Local iron works.—To carry on the current business of the country local iron works are necessary, where castings

can be made, repairs executed and a great variety of miscellaneous work undertaken that cannot be obtained from abroad without an expenditure of time and trouble which effectually protects the works from foreign competition. All the leading firms in Calcutta, Bombay and Madras are in European hands and though there are some native works of this description, they do but a very small share of the business and that the least profitable.

The Jute industry.—Bengal has a practical monopoly of the supply of jute to the world and India itself consumes an enormous quantity of the manufactured article. Protective duties would in no way help the Indian jute manufacturer but that fact offers no consolation to the Indian protectionist for the industry is almost entirely in European hands. It is needless to go into details—the industry has, of late years, been very profitable and the ryots who grow the raw material are in a prosperous condition, so also are the operatives in the jute mills but the industry affords no scope for the employment of educated Indians, and the running of the mills and the management of the business is in the hands of men who have been trained in Dundee.

Tea.—India and Ceylon may now be said to enjoy a monopoly of the tea trade. It is true that there is a good deal of tea made in China, but it does not compete with the Indian tea. This industry is partly agricultural and partly manufacturing. It is carried on to some extent in the hills at a considerable elevation, but the greater part of the area under tea is in the low country in Assam. This industry requires capital, organisation and some technical knowledge and has yielded a good return on the money invested in it. One would imagine that it would afford an admirable outlet for the surplus energies of educated India but it has not done so, and for all practical purposes, it may

be regarded as a British Industry located in the tropics and employing Indian cooly labour.

Rubber.—This is another planting industry which I have selected because it has been only recently established in the country ; as yet it is an industry of minor importance, but the outlook is extremely promising. There is absolutely no reason why Indian capital and Indian brains should not control the industry, but, as a matter of fact, it has so far been treated with complete indifference, and there seems to be little likelihood of the industry pursuing a course in anyway different from that which tea has followed.

Coal Mining.—In Bengal, Assam, and over limited areas in several other parts of India there are very valuable deposits of coal. Except at the great seaports, the industry is completely protected not only by the sea freights on foreign coal, but also by the still heavier Railway freights. Small quantities of foreign coal are still landed in India, but it is probable that most of it is brought out as ballast, and it, at any rate, has no effect upon the Indian coal trade. Indian coal mines are shallow, free from gas and very easily worked. They are now beginning to attract attention in Bengal and mining classes have been established but the Bengali has yet to prove that he can be trusted as a miner. Possibly there are some native coal mines in Bengal but coal mining is and, is likely to remain, an industry almost entirely in European hands.

The Petroleum Industry.—Like coal, this has developed rapidly in recent years, but is confined to certain rather remote parts of the country such as Assam and Burma, to which educated India, is almost as much a stranger as the enterprising Briton, who has gone there to develop these valuable oil deposits. The industry is carried on by companies with very large capital and it is certain that, to

whatever extent it may be developed, it will remain under European control.

Gold Mining.—This a very speculative industry which, one would imagine, would attract a race so extraordinarily fond of the excitement of litigation and its sporting chances. The remains of ancient workings show that in olden times gold mining was extensively pursued in many parts of the country and all the superficial deposits were worked out centuries ago. The modern industry is confined to the South of India, and as yet has only been successful on the Mysore plateau, but there the profits have been very large. To initiate the industry and carry it on successfully requires considerable technical knowledge and a great deal of skill. It has not hitherto attracted native capital and it is quite certain that till it does so the Europeans who invest their money will entrust its expenditure to those who have gained practical experience in mining development in other countries.

In his presidential Address to the fourth Indian Industrial Conference in 1908, the Hon'ble Rao Bahadur R. N. Mudholkar pleaded for some restriction on the grant of mining concessions to enterprising outsiders. He said: "If we do not show enterprise and energy, if we do not equip ourselves with the requisite knowledge and working capabilities, if we do not find the needed funds, there is imminent danger of outsiders reaping the entire benefit which the country's mineral resources are capable of affording."

The facts just presented regarding these industries are common knowledge to every person who pretends to the least knowledge of Indian economics, but I am afraid that their bearing upon the question of protection has never been properly considered. It would seem that the genius of the people of India does not tend towards modern industrialism and a rapid develop-

ment in that direction is hardly possible. In addition to lack of technical knowledge and experience in managing complicated organisations, there is but little inclination for co-operative enterprise by joint stock companies. Everything must have a beginning and for the present industrialism on a small scale is best suited to the needs of India. Although there is a large amount of precious metal in the country, it is widely diffused and there are no signs that the owners thereof are likely to entrust it to those among their countrymen who are aspiring to become industrial leaders without the preliminary training that is essential.

The leaders of political and economic thought in modern India are agitating for a protective policy mainly on the ground that it is necessary during the infant industries stage, and that later on, when adolescence or maturity is reached, they think it will be no longer necessary. Is it possible however to cite any instance of a country which has adopted a protective system and afterwards has succeeded in getting rid of it. The American and German industries have long ago ceased to be infants, and there is a very large body of opinion in both countries in favour of free trade, or at any rate of a material reduction in these import duties. But so far, the vested interests which have grown up under protection have proved too strong and it is hardly likely that any change will be made unless it is done with revolutionary violence. Apparently it is expected that under a protective system, the internal competition among the manufacturers will tend to reduce prices, but there is no evidence anywhere in the world to show that this is likely to happen. Protection engenders a wonderful system of trade organisation and the trusts of America and the cartels of Germany should at least serve as warnings of what is likely to happen in this country.

It seems to me hardly necessary to make out a stronger case than I have done, but I would suggest to any one, who is not convinced by the facts I have brought forward, that he should examine carefully the results of the Swadeshi movement which has spread throughout the length and breadth of India.

III

The administration of British India presents to the advanced student of political economy an admirable series of examples of the application of the principles of the science to the practical problem of maintaining law and order among more than 300 millions of people. He can study the land question and contrast the defects of private ownership in land as exemplified by the permanent settlement in Bengal with the advantages of land nationalisation which is at the basis of the system of ryotwari tenure. In the excise duties on cotton goods manufactured in the country, the doctrinaire free trader will rejoice to see that in practice, the levying of import duties on foreign merchandise is not incompatible with the most strict adherence to his principles of economic faith. At the same time those who hold that the *laissez faire* doctrines of the Manchester school of economists are inimical to the interests of the bulk of the community, will rejoice to see that the State has recognised the part which it can play in the corporate life of the people in its railway systems, in its irrigation works and in its frank recognition of its duty to prevent death by starvation in famine times.

Truly Administrators of British India have studied political economy to some purpose and have shown no small amount of sagacity in the practical application of its theories to the problems of administrative work, but their critics, on the other hand whatever their the-

oretical attainments may be, have failed entirely to apply the principles of the science in dealing with the situation in which they find themselves placed. Facts are stubborn things, but they are ignored altogether or count for very little when the Indian Economist is endeavouring to work up a political grievance out of the industrial inferiority in which the country is placed. He is prone to attach much importance to the alleged exhaustion of the soil—"earth butchery" he is pleased to call it—and revels in the pessimistic conclusions which he can draw from an application of the law of "diminishing returns:

The resources of science have hardly yet been applied, and until they have been, the loss of fertility of the soil, if such is occurring, is due to ignorance, apathy and want of enterprise or capital on the part of the cultivators. I doubt very much if the Irrigation Officers of the Public Works Department or the experts now attached to the various Provincial Agricultural Departments would admit that India is in sight of the time when that economic bogey, "the law of diminishing returns" will come into operation.

The value of crops is everywhere rising, irrigation is extending, improved methods of cultivation are becoming better known ; capital, is however sadly lacking and even where available its application to the soil is rendered extremely difficult by the minute area of the individual holdings of each cultivator. Why therefore talk of "the law of diminishing returns"? The judicious investment of capital in the soil almost everywhere yields a handsome return and better than can be expected from most forms of industrial enterprise.

Quite recently I have learnt that in the Gwalior State the steam ploughing experiments which have been con-

ducted at the instance of the Maharajah have resulted in an increase of the yield from black cotton soil of between 200 and 300 per cent, and I understand it is proposed to develope work in this direction as rapidly as possible.

All over the country one finds herds of worthless cattle grazing on waste land and if the people could only be brought to appreciate the enormous importance of scientific cattle breeding combined with the growth of suitable fodder crops, the resulting increase in their prosperity would be astonishing.

India grows more sugarcane than any other country in the world, but it is now unable to supply its own internal consumption and year by year the imports are steadily increasing. It is generally admitted by those competent to express an opinion on the matter, that Indian sugar growers are suffering, not from the effects of the law of diminishing returns, but from their neglect to keep abreast with the improved methods of cultivation which have been adopted in other countries.

In the south of India we have less than 400 oil engines and pumps at work, yet many of them have repaid their cost within two years and most of them will do so with in four years of the time when they started to lift water for irrigation. There is room for one hundred times as many pumping stations as have been installed and crores of rupees can be profitably invested in them. In other parts of India there is a similar field for the employment of capital, and I have good reason to believe that capital to the extent of fully one hundred crores of rupees could be invested, not at once but in course of time, in irrigation by pumping if the people of the country were alive to the advantages which it offers. When the profits derived from irrigation are better appreciated, it will be practicable to levy higher water rates than at present and great irriga-

tion projects which are now pigeonholed will be carried out. Over millions of acres the productivity of the soil will be doubled or even trebled and by a more extensive use of mechanical appliances the labours of the cultivator will be reduced and his increased efficiency will undoubtedly be accompanied by a substantial rise in his standard of living.

Till all these things have happened and till the pressure of the population on the soil is at least double what it now is, we need not consider the law of diminishing returns. To enclose India in a ring fence, such as the protectionists desire, is either to deliver the people over to the enterprising foreigner who would exploit the material resources of the country and its enormous supply of cheap labour, or to perpetuate the present state of inefficiency and apathy from which we are being rudely awakened by the pressure of competition from the outside.

It is necessary that industries should develope, but let their growth be natural and suited to the environment of the people. The great manufacturing cities of the West are in many ways a blot on our modern civilization and those, who have the interests of India at heart, may well be asked to reflect on the condition of such towns as Calcutta and Bombay, before they advocate the introduction of a fiscal policy which would tend to foster the growth of such centres of population and would enable the enterprising foreigner to indirectly levy a tax on the whole country for his personal benefit. The Indians, who cry for protection, do not realise the conditions under which they are now living or the futility of their measures for the development of Swadeshi enterprise and it is fortunate for them and for the country at large that there is little hope that the fiscal policy which they advocate will be adopted.

Hitherto, as the late Mr. Justice Ranade admitted India has vastly benefitted by its close connection with the richest and most enterprising country in the world and the exchange of products between the two has been a great mutual advantage. Protection in India would alter all this and an artificial system would be built up which protection would be needed to maintain. In Japan such a policy has been pursued with great success, but Japan is an independent country and its people have never been subjected to foreign dominion. The Japs apparently possess the essential qualities of a dominant race and they have exhibited in a high degree the energy, perseverance, power of self-control and ability to combine which are required in those who would be industrial leaders and carry on manufacturing operations on a large scale. Protection for India really means protection for the foreign manufacturer and this the Indian protectionist is driven to admit, but he weakly contends that it would only be for a time and that ultimately Indians will succeed in ousting the pioneers ; and so sure is he of this ultimate result that he thinks it would be worth while to temporarily pay the price.

The Hon'ble Mr. R. N. Mudholkar in his address to the Industrial Conference very forcibly drew attention to the obvious failure of the Swadeshi movement, but, in the remedial measures which he proposed, he failed to recognise that the creation of an industrial India involves a great change in the ideals of the people and their outlook on life. There are many who say that such a change is undesirable and those who have studied the question are forced to admit that so vast a change in the habits of the people can only be effected gradually and must be spread over many generations.

Not less fallacious is the prevalent idea that industrial

development is needed in India to provide employment for the landless labourer and to relieve the pressure of the population on the soil. This too in the face of an almost universal outcry of the scarcity of labour and that this outcry is well founded we have ample evidence in the steady rise of wages. It is only in famine times when agricultural operations cannot be carried on that extensive unemployment and the accompanying destitution exists. Industrial development will provide no timely showers of rain and consequently will not help the agricultural population. All the mills, workshops and factories in India worked on modern lines only employed in 1908-09, 948,000 people and if the number were trebled, which would mean an enormous industrial development, it would hardly affect the agricultural labour market at all. Industrial development will increase the general resources of the country and, so far as the profits from such development remain in the country, its resources to meet the strain of famine times will be increased, but industrial development is not the direction in which we should look for ways to diminish the effects of famine. A failure of the rains means a loss of crop and as long as that loss of crop occurs over large areas nothing can be done to prevent unemployment on a great scale. The only remedy is irrigation, which means a more extensive conservation of the available water supplies, and it is fortunate that our Engineers are steadily obtaining more complete command over natural forces so that no one can now predict the time when their resources will be exhausted.

During the last 20 years India has passed through a prolonged series of unfavourable seasons and there is some reason to believe that this cycle will be succeeded by one in which the meteorological conditions will be more favourable. If that be so, we may anticipate in the future a still more

rapid development both in agriculture and industries than has hitherto taken place. Moreover, the educated classes in the country are thoroughly alive to the necessity for engaging in productive work and though their efforts so far have not met with much success, experience is being gained and the lines along which progress is possible are becoming clearer.

It is urgently necessary that the economic situation should be understood and that there should be no time or energy wasted in working on wrong lines. It is for this reason I consider it desirable that the fallacy of protection as a remedy for the growing difficulties of the educated classes should be exposed. Exaggerated impressions are fostered regarding the natural resources of the country and it is eminently desirable that as soon as possible it should be realised that they are mainly of an agricultural character. Minerals are widely diffused, but so far as our present knowledge goes it is only in the coal fields of Bengal and the oil fields of Burma that they are of great potential value. It is possible that further discoveries may be made which will alter the situation, but for the present, at any rate, it is outside the range of practical considerations to attach any economic value to the enormous deposits of iron ore which occur in various parts of India and notably in certain districts of this Presidency. The poverty of India is in the main due to the cleavage between the intellectual and the labouring classes and the policy of the future should unquestionably be directed to rendering it possible for the former to assist the latter. The demand for education is spreading and our efforts should be concentrated on making it of a more practical character. The administration is probably too much in the hands of men whose training has been along literary lines and it would certainly be advantageous in the future if more

room could be found in the public services for men whose practical and constructive faculties have been developed.

To conclude, Indian economics have hitherto been studied in an extremely superficial way, and, generally, in the interests of some particular section of the community. There are signs that this unsatisfactory state of things is coming to an end and that broader and more statesmanlike views will ultimately prevail. Tariffs, protective or otherwise, are potent weapons for good or ill and according as they are used wisely or otherwise they may promote the welfare of, or cause misery and distress to millions. Briefly, my view at the present time is that India is not in a position to benefit from a protective system of tariffs. Whether it will be so or not, in a future more or less remote, entirely depends upon the direction in which future progress both economic and social will be made.

CHAPTER IV

AGRICULTURE AND INDUSTRIAL DEVELOPMENT

I

The marked rise in price of agricultural products throughout the world has naturally attracted the attention of economists and various reasons are assigned for it. The cost of manufacturing operations has decreased and the price of manufactured goods shows a steady decline excepting in so far as it has been affected by the enhanced cost of raw materials. Gold has depreciated relatively to wheat, but not to iron or copper; whilst it has enormously appreciated in comparison with such metals as aluminium and nickel, and with many hundreds of chemical products, the cost of the production of which has greatly decreased owing to the application of scientific methods in dealing with them. It is true that in recent years there has been a great increase in the production of gold, but no inconsiderable proportion of this increased supply has been withdrawn from the market on account of India and in view of the still greater increase in the volume of trade throughout the world it is almost certain that there has been no marked change in the real value of the standard by which the value of other commodities is measured.

The increase in the prices of agricultural produce is undoubtedly in the main due to an increased demand for them, owing to the rise in the standard

of living and to the increase of population in the civilized parts of the world. America has almost ceased to be a grain exporting country and in a few years it will have difficulty in supporting its own rapidly growing population. Germany has already reached this stage and is dependent on foreign sources of supply to an ever increasing extent. These facts have an extremely important bearing on the economic situation of India and suggest, at least, that it is worth while enquiring whether the dependence of the country upon agriculture is likely to be such a source of weakness in the future as it has hitherto been considered in the past. Year by year the value of agricultural produce increases and the cost of freight diminishes ; that is to say, the cultivator in this country is able to obtain a gradually increasing amount of gold or manufactured goods in return for the surplus crops he has to dispose of.

The world is moving very fast and in another generation India may have no surplus foodstuffs to dispose of, but that seems hardly likely as the undeveloped or latent resources are extraordinarily great. The area under cultivation is capable of extension by at least 50 per cent, and there is but little doubt that the area under irrigation can be doubled. To what extent improved methods of culture, a general use of artificial manures and a rational policy in regard to live stock will increase the yield of the soil, I am not prepared to estimate ; but taking all the factors enumerated into consideration we may safely reckon on an annual harvest more than double that now obtained. India sustains its rapidly increasing population with comparative ease and will continue to do so for a long time to come, provided the people remain contented with their present low standard of living. Notwithstanding its teeming millions

in an average year there is employment for all and in many parts of the country there is a distinct shortage of labour.

Whilst I do not deprecate in the slightest degree the efforts now being made to establish industries in this country, I think it is well that we should bear in mind that possibly the disadvantages of relying almost entirely on agriculture have been somewhat overrated and that in consequence an exaggerated idea has been created as to the necessity for concentrating efforts on industrial developments. It has been asserted, over and over again, that to give full play to the activities of a nation there must be variety for the occupations of its people, and some approach to equality in the opportunities offered by commercial, manufacturing and agricultural pursuits. There is no doubt that in the past, and even at the present time, the great industrial nations of the world are far wealthier and more progressive than those which, in the main, have been compelled to confine themselves to tilling the soil; but the question arises whether this is likely to be equally true in the future.

So long as agriculture was based on traditional methods and rules of practice it offered little scope for the exercise of trained intelligence, but in recent years a more scientific procedure has been adopted, and in advanced agricultural practice chemistry and engineering play an ever increasingly important part. In the United States, the Western farmer is as keen a man of business as the Eastern manufacturer. He is always making experiments and trying to circumvent the difficulties which he has to encounter, whether due to natural circumstances or to the inadequate supply of labour which he can command. A farmer working on a large scale and with insufficient capital will always be at the mercy of the

weather. In a good season he will flourish, in a bad one he is brought to the verge of ruin. The conditions are rapidly changing in America and Australia, and year by year the progress of irrigation and improved methods of cultivation are rendering farming a less precarious business. Machinery plays an increasingly important part in agricultural operations and steadily modern farming is becoming akin to complex manufacturing operations.

In India there are no large farms and the cultivators have but little capital. They are burdened with an enormous number of inferior or useless cattle for whose maintenance an undue proportion of the soil is occupied with low grade crops. It is estimated that there are at least 120,000,000 bulls and bullocks, cows, buffaloes and young stock in the country. Besides ploughing and carting, the lifting of water from wells for irrigation employs millions of the best cattle and costs the country not less than 40 crores of rupees a year. Here is a vast field for industrial work in devising mechanical appliances to suit the local conditions. The movement in favour of Co-operative Credit Societies for the ryot will ultimately place a large amount of capital at the disposal of the cultivators and the difficulties connected with the introduction of machinery among small holders can be met by co-operation on an extended scale.

The natural wealth of India is mainly agriculture and it seems to me obvious, that in view of the rising value of agricultural produce, enough is not being done to improve the archaic methods in vogue in this country. The industrial development, for which there is so great an outcry, must be based on the improvement of agriculture. The area under cultivation is steadily increasing and, during the last ten years, in this Presidency even at a more rapid ratio than the population,

Labour is in consequence scarce and yet only in a very limited degree recourse is had to labour-saving appliances. The educated Indian, looking mainly to the future of the class to which he belongs, recognises the necessity for a more rapid rate of progress in industrial matters and he cries aloud for fiscal protection as the sovereign remedy for the economic ills to which the country is subjected by the free trade policy imposed upon it. Industrial protection can only be obtained at the expense of those dependent upon the land for their means of subsistence and to build up manufacturing industries the development of agriculture is to be checked by the imposition of additional burdens.

It is not sufficiently recognised that for industries to flourish in this country they must have an assured home market. The spending power of the people of this country almost entirely depends upon agricultural progress and the more this is furthered by improvement in the means of communication, by the diffusion of scientific knowledge, by the introduction of labour saving appliances and by the general education of the cultivators, the sooner will it be practicable to establish local industries for the supply of local needs. It is an axiom, the importance of which cannot be too clearly recognised, that before manufactures can be started there must be a market of sufficient size to absorb all their products. Protection, I fully admit, by cutting off outside sources of supply, would create such markets in the case of certain commodities which are now largely imported, but it would be at the expense of the general community and most probably for the benefit of the foreign *entrepreneur*.

In the industrial race the only asset which India possesses, that is of supreme value, is an abundant supply

of cheap labour and the material progress of the country depends largely upon the education of these labourers so as to render them more efficient workmen. The labour difficulties are entirely due to the crude methods of working, to the neglect of labour-saving appliances and to the absence of any efforts to train labour. The present pseudo scarcity of labour is indirectly a great advantage as it is raising the status of the labouring classes and at the same time providing a much needed stimulus in favour of the use of labour-saving appliances. Evidence of this is to be found in this Presidency in the growing demand for small motors to drive pumps, oil mills, rice hullers, cotton gins, fibre extractors and sugar mills. In the Punjab there is a demand, in the irrigation colonies, for harvesting and thrashing machinery and in other Provinces, in a lesser degree, for a great variety of machines to take the place of manual methods of working.

As Europe draws its supply of raw vegetable produce from India and other tropical countries, so India in the future will have to depend for the raw material of her manufactures mainly upon countries more favourably situated than she is for their production. Assuming the success of the attempt now in progress to establish the manufacture of iron and steel on a large scale under the direction of the Tata Brothers, it is at least doubtful, owing to the high cost of transport by railway compared with that by sea, if they will ever be able to compete with the foreign producers of such material in the markets of Southern India. On the other hand, if in course of time the demand for oil-engines and pumps in the South of India continues to increase, it is absolutely certain that they can be manufactured out here on a large scale as cheaply as in England or in America. All that is wanted to ensure the success of Iron Works devoted to this

particular branch of manufacture is a sufficiently large local market to absorb the whole of the production. If, therefore, we wish to establish the manufacture of such machines in this country, our efforts should be directed to the creation of a market for them. The greatest users of machinery should be the ryots. The more advanced their agricultural practice, the greater will be their profits and in an equal ratio, the greater will be the spending power of the community.

The first great need of Indian agriculture is an assured supply of water and it is almost as important that the ryots should learn how best to utilize an assured supply. Here and there on a small scale their practice has reached a high degree of perfection, but generally over the country they have a vast amount of leeway to make up and it is only by the diffusion of education and knowledge that their innate conservatism will be overcome.

The irrigation policy of Government is based upon far too low an estimate of the value of an assured water supply and only when both the Government and the educated classes in this country have an accurate conception of the real value of water will funds be made available for the pursuit of a vigorous policy in respect to irrigation and agricultural development. It is rightly considered that public funds should only be devoted to the construction of irrigation works when the return to be expected from them will be sufficient to prevent the works becoming a permanent burden on the finances of the country. What are classified as productive works are expected to yield a direct return on the money invested in them over and above the interest charges. What are known as protective works are expected to yield some return but not enough to enable them to pay their way. The direct loss is counterbalanced by the reduction in cost

of famine relief operations consequent upon the protection afforded by the works.

In the neighbourhood of Poona, sugar-cane is grown under unusually favourable conditions with an assured water-supply from the Nira Canal. This irrigation work involved a very large capital outlay, but the demand for water is greater than the supply and the rate for sugar-cane is now Rs. 50 per acre per annum. So far as Government irrigation works are concerned this may be considered an exceptionally high rate and, in fact, there are but few places where rates as high as Rs. 15 per acre are charged. On the other hand, in Zamindari lands and private irrigation works, the cost of irrigation varies from Rs. 25 or 30 per acre to at least Rs. 100 per acre per annum. The ryots in the Kistna Delta pay a water rate of Rs. 5 for single crop irrigation. The ryots who own dry lands commanded by the canals are perfectly willing to pay this water rate in addition to the cost of pumping water from the canals. This costs them at least Rs. 10 an acre. It will be seen, therefore, that it is more profitable to grow irrigated crops and pay a water rate of Rs. 15 per acre than it is to grow dry crops and be dependent upon the season. The average cost of well irrigation is somewhere about Rs. 5 per acre per month, and yet when big irrigation schemes are under construction the financial returns are based on water rates which were obtained twenty years ago when the economic conditions were greatly inferior to what they are now. In the past it has been possible to construct irrigation works to command large areas of land at a very low cost, but all or nearly all the favourable sites for such works have been occupied and the big irrigation works of the future will cost possibly about ten times as much per unit of water available in the field channels. To make the works pay the water rates will have

to be high, but even then the profits on wet cultivation will prove much larger and more reliable than from the existing dry cultivation. There is but little doubt that Government would gladly accept this view of irrigation if the value of water as expressed in currency units was more accurately recognised. The ryot often pays in kind from Rs. 50 to Rs. 60 per acre per annum for his water, but he would be aghast at the idea of paying one-third of this amount in actual currency. In this direction, however, progress is being made which may be claimed as one of the results of irrigation by pumping, though there is also another view which would suggest that the extension of irrigation by pumping is the outward and visible expression of a profound change in the economics of rural India.

If once it is recognised that these are the true principles which must govern the policy pursued in this country in regard to material development there will, I think, be but little difficulty about creating a healthy and vigorous industrial system.

II

INDUSTRY ON A SMALL SCALE

Educated India has realized for sometime past that the indigenous industries of the country are one by one disappearing before the competition of free imports and that the proportion of the population solely dependant upon the soil for subsistance is steadily increasing, whilst in more progressive countries an exactly opposite tendency is clearly visible. More than this, however, is at the bottom of the economic unrest which pervades the country. It is the perception that the unequal development of rural and urban life provides inadequately for the employment of the varied forms of intellectual activity which education has called into existence. Inaccurate and

vague ideas still prevail regarding the natural resources of India and there is a widespread feeling that it is the policy of England to keep India in economic subjection rather than encourage a vigorous development of industrial activity in the country. The *laissez faire* policy of the Victorian Era is neither understood nor appreciated in this country and the fact that it still, to a large extent, dominates English political life, for reasons totally unconnected with India, is scarcely recognised.

This all points to the urgent necessity for the establishment in India of an institution run on similar lines to the London School of Economics and Political Science, which provides for the study of facts relating to, and for the diffusion of knowledge regarding social and economic problems. Something has been done in this direction in Bombay, but the movement which started in the cold weather of 1908-09 by engaging Professor H. B. Lees-Smith, at present M. P. for Northampton, to deliver a course of lectures on Indian Economics has not yet borne definite fruit. In London, it is true that increasing interest is being taken in Indian problems and attention may be directed to the writings of both Professor Lees-Smith and Sir Theodore Morison. Their studies, however, are made from the outside and without that intimate knowledge of detail which can only be found among people on the spot, in daily contact with the various phases of the problems which require elucidation. Changes are taking place so rapidly in India and the area under observation is so large that it is difficult for any individual to keep in touch with the efforts that are being made and with the progress which is definitely accomplished. Organization is necessary to accomplish this and to a large extent it is lacking. The statistical publications of the Imperial and Local Governments offer

vast quantities of undigested material, which is availed of mainly to furnish evidence in favour of preconceived theories and opinions. Anything like a masterly analysis of the facts and a complete exposition of the situation has never been attempted.

Not only in religion and philosophy is there a vast gulf between East and West, but it is equally apparent in the outlook on material and more mundane affairs. The nineteenth century witnessed the destruction of the indigenous Indian industrial system, which gave way before the modern commercialism of the West, because of its own inherent weakness. In the twentieth century we recognise the urgent necessity for constructive work, for providing India with an industrial system suited to the idiosyncracies of the people and capable of absorbing the surplus creative energy which is slowly becoming apparent. In this work the State must play an important part. Its influence will be enormous, whether it adopts a *laissez faire* policy, or actively intervenes and endeavours to influence the course of events to bring about a definite result. To frame a policy it should understand the situation and know what forces are at work, what material there is to deal with and what latent resources there are which can be made use of. Already there is much activity in various directions, many experiments are being tried and many failures are writ large in the lives of pioneers in this work. Nevertheless the record of progress is by no means unsatisfactory, and it is worth while to pause for a moment and look around to ascertain if possible what is the general tendency in this movement towards industrial development. If we can discover the line of least resistance we may be able to concentrate effort in that direction and avoid in the future much waste of energy and capital in futile efforts foredoomed to failure.

During the past six months I have spent a considerable time on tour in this Presidency and have made two long journeys through other parts of India. I have had fair opportunities of seeing what industrial work is going on and of judging in what direction progress is being made. I now propose to briefly set down the general conclusion I have come to in regard to purely indigenous efforts to improve the conditions under which industrial work is carried on in India. I purposely exclude from this survey the larger enterprises under European or Parsee control and my remarks do not apply to the cotton industry as carried on in spinning mills and weaving sheds.

At the last Industrial Congress the political leaders lamented the small results produced by the Swadeshi Movement and I am in agreement with them that it has proved a practical failure. I would only emphasize the point to drive home the lesson that under the conditions that prevail, through the length and breadth of India, there is no hope that a mere political sentiment will have sufficient driving force to overcome the difficulties inherent in changing from the ancient system of hand-labour, which has prevailed from time immemorial, to the modern European factory system, evolved under conditions which do not exist out here and which are not likely to exist out here within any period of time which need concern us.

Nearly everywhere there is evidence of a growing scarcity of labour which, combined with a general rise in the price of food, has tended to enormously increase the cost of work and forced employers to look to labour saving appliance as a means of reducing their wage bills. Whilst then we may regret that there is little evidence of industrial development in the direction of new industries we may rejoice that important changes are taking place in the methods of conducting existing industries. All

these are intimately associated with agriculture and the sum total of my observations is that in these industries power and machinery of an automatic character are replacing the old ways of doing things.

The Allahabad Exhibition afforded some evidence of this, and as a show its success was largely due to the exhibits of machinery manufacturers, but the failure of the exhibition to do business on a large scale was due to the inadequate appreciation of the conditions peculiar to India, which demand special consideration from those who would cater for the market now opening out. If English or foreign manufacturers want to meet the demands of the Indian market they must make a special study of the conditions under which their machinery will have to work. It is a curious fact, but nevertheless one of great importance, that the economic conditions in India are such that competition amongst importers does not facilitate but rather hinders progress. With an assured market better terms could be offered and monopoly rather than free competition is the need of the country. I can cite no better example of the truth of this statement than by drawing attention to the extraordinary popularity of the Singer's Sewing Machine which, as a labour saving appliance, is in general use throughout India. There are a number of rival sewing machines of possibly nearly equal merit, but the superior organization of the Singer Manufacturing Company has gained for itself a practical monopoly in the supply of these machines to India, and the absence of competition gives them an enormous business which enables them to supply new machines on very favourable terms and to provide facilities for their repair and for the renewal of damaged parts, without which it is quite certain they would not be largely used.

With the exception of possibly the Punjab where the

area under cultivation is growing rapidly and where the population, owing mainly to plague, has actually decreased during the last ten years, I find that it is in the Madras Presidency that the largest amount of progress has been made in the direction of superseding hand-labour by machinery. It will be convenient therefore only to deal with the facts which have come to my notice in this Presidency. These all point to one definite conclusion —that so far the people of the country are only capable of undertaking industrial work on a comparatively small scale. Many such enterprises have proved successful whilst attempts to operate on a large scale have usually proved abortive or, if actually started, have ended in ignominious failure.

It may be well to briefly state the reasons why industrialism has, even under European or exceptional native management, failed to establish itself in the country except along comparatively limited lines. In connection with some of the staple products of India, the chief of which are cotton, wool, jute, sugar and wheat, flourishing manufacturing industries have sprung up, but outside these, so far, neither European nor Indian has succeeded in accomplishing much. In the discussions on this subject it appears to me that sufficient weight has not been given to the fact that European merchants and manufacturers have for nearly a century been doing all they could to create an industrial system. The fact that they have met with great success in certain directions and that their efforts in others have proved of so little avail may be taken as evidence of the inherent difficulty of starting enterprises in this country. Having tried and failed, they are not altogether to be blamed if they have in recent years devoted their time and attention and employed their capital in creating a big foreign trade at

the expense, more or less, of the indigenous industries. Unquestionably the merchants have found it easier to finance agricultural operations, to export produce and to import foreign manufactures in exchange. There is ample evidence to show that much capital has been wasted in efforts to establish new industries in this country. The difficulties were due to the lack of central markets, to the absence of skilled labour, to the intensity of foreign competition, to the poverty of local resources, to the cost of internal transport, to the inability to obtain a monopoly and finally to an imperfect study of local problems.

It is only in recent years that Educated Indians have become really interested in industrial questions and the mere fact that they are now taking an interest in such questions does not in any way facilitate their solution. The simplest suggestion, and that which is most clamoured for, is a protective tariff, but as I have already pointed out protection will be of little use unless you exclude the foreign capitalist and manufacturer. It looks at first sight as though we were at an *impasse* and as though matters will have to drift for themselves as they have done during the past 50 years. A survey, however, of the work going on encourages me to think that the problem will be gradually solved in a perfectly natural way without the necessity for any drastic fiscal legislation, which, if it benefits one class of the community, must necessarily throw a heavy burden on another. This is not intended to be a general statement of universal application but only as true of India in its present state.

Modern industrial enterprise in the West tends towards production on a larger and larger scale, but the conditions are totally different in India and along certain lines, at any rate, it is becoming evident that enterprise on a small scale is likely to be more profitable and is certainly better suited

to the capabilities of the people. The reasons for this are numerous and may be stated briefly.

1. The distrust and suspicion prevalent among business men which prevents them from associating in Joint Stock enterprises of indefinite duration.

2. The absence of large capitalists and the unwillingness of small capitalists to entrust their money to experts to carry on business.

3. The very feeble banking system developed in this country and the almost entire absence of credit.

4. The numerous obstacles to individual private enterprise imposed by the undivided family system.

5. The dependence of nearly all forms industry either on locally grown agricultural produce, or upon mineral developments, which in richness compare unfavourably with similar deposits in other parts of the world.

6. The fluctuating character of the season and the intermittent supply of most of the raw produce available for manufacture, which renders it impracticable to keep costly plant and machinery running through any large proportion of the year.

These are all reasons which explain the failure of indigenous industrial enterprise on a large scale. Success on a small scale is possible because it avoids the rocks upon which larger enterprises have been wrecked. The investment of a large capital in machinery and plant means heavy standing charges which have to be met, year in and year out, whether the plant is running or not. Indian industries must at the outset deal mainly with local produce, mostly of an agricultural character, and they are at a great disadvantage in competition with similar

industries in Western countries, since it is impracticable for them to draw their supplies from all parts of the world. A flour mill in Delhi can only obtain wheat from the Punjab or from the neighbouring districts of the United Provinces. The crop all comes in at one time and must be stored in granaries, either attached to the mill or belonging to the cultivators, till the time comes for converting it into flour. A flour mill in Hull or Manchester derives its supply of wheat from all parts of the world and every month in the year cargoes are coming in, at one time from the United States, at another from Russia, at a third from the Argentine, at a fourth from India. By a judicious blending of the different crops superior flour can be made, but in the Punjab there is only one kind of wheat and only one possible product. There is a big local market for it because people are willing to purchase the products of the mill to save themselves from the trouble of grinding the wheat by hand. A large mill can produce a finer quality of flour than a small one but the local demand is for what are termed low grade flours and these can be produced on a comparatively small scale with nearly the same economy as on a larger one. The industry is and must remain a local one and, as the cost of labour rises in the north of India, small wheat grinding machines will prove of great value and each locality will have its own mill, grinding its own wheat, and keeping transport charges down to the minimum possible. This was the condition of things in England and Europe till a comparatively recent date. Up to as late as 1880 there were as many 10,000 flour mills in Great Britain and Ireland. The ever growing dependence of the British Isles upon foreign sources of wheat supply has concentrated this trade in the sea ports round the coast and, within the last 30 years, thousands of small mills have

succumbed to the competition of the large mills established at places convenient for handling foreign cargoes.

A large part of the trade of India consists in the export of food grains and oil seeds and though it would be of immense advantage to the country if these could be manufactured into finished products the conditions are usually unfavourable for doing so. In the case of paddy it is convenient to convert it into rice before it leaves the country, because the paddy husk is of no greater value in Europe than it is here, but with wheat it is different. There is a far better market for bran in Europe than there is in India and it is much more convenient to transport the wheat berries in their natural state than it is to separate them into flour and bran and send them both abroad. Both wheat and oil seeds can be exported in bulk or in gunny bags, but if the oil is extracted from the seeds in India it has to be sent out of the country in expensive drums or casks and there is little or no hope that any profitable business can be done on lines other than those hitherto pursued. The large factories of India may possibly be able to manufacture at a smaller cost than the small factories, but they have to derive their supplies of raw material from a greater distance and they have to distribute their finished products over a larger area. This means increased expense in marketing the goods, and the savings effected by concentration of manufacture are more than counterbalanced by increased transport charges. The small mill can therefore hold its own against the large one and this it will probably long continue to do.

Apart from the use of oil engines and pumps for lifting water for irrigation there is no direction in which the labour saving machine is coming more largely into use in this Presidency than for cleaning rice. For the export trade it may be of advantage to have large plants

near the ports of shipment but for the local trade small mills are springing up all over the country. Most of these consist of a single set of machines driven by an oil engine and the steadily growing demand for such plants is evidence that they suit the conditions of the country and that the owners are finding them profitable to work. The gradually growing demand for labour-saving machinery is the dominant feature of the present day and the demand gradually leads to marked improvements in the efficiency and suitability of the machinery which can be supplied. Whilst there is but little probability that India can ever become a great manufacturing country there is every reason to hope that it is on the road to utilising its resources in a better manner than hitherto. Our policy should be to foster this development in every way, to show the people how to spend their limited capital to the greatest possible advantage, to bring the needs of the people to the notice of manufacturers, both in India and other parts of the world, and to supply such industrial and technical training as is necessary.

The invention and perfection of the oil engine has been of great advantage to the small industrialist. It enables him to obtain the power he needs on terms which will compare favourably with even the largest installations and I doubt not that much more can be done in this direction if we can only induce and encourage inventors, mechanicians and engineers to turn their attention to the perfection of machinery for working on a comparatively small scale. The tendency, hitherto, has been all the other way, but now that it is recognised that in tropical and semi-tropical countries, where labour is cheap and the cost of living low, there is a vast field for the employment of skilled manual labour, it is certainly worth while doing all we can to evolve an industrial system based on manual production. Our efforts to popularize the fly shuttle loom

and improve indigenous weaving appliances are an example of work in this direction which has met with considerable success and has enabled the weavers who have adopted them to recover much lost ground. The establishment of small weaving factories, directed by men of superior training and intelligence to the average artizan is a further step in industrial progress and a great advance on the primitive system hitherto in vogue.

In England, Germany and America the concentration of the population in large towns and cities is not without serious disadvantages and those disadvantages are greatly magnified in tropical countries. It will not be possible to avoid this altogether in India nor is it desirable to do so, as, owing to the absence of convenient harbours and seaports round the coast, the trade of the country must inevitably be concentrated at the few sea ports which we possess. The Railway system tends to concentrate production in certain centres, but if it becomes generally recognised that a small scale of working is better suited to the conditions in India, it is quite possible to modify the methods of railway management so that they shall be made to serve the best interests of the country and no longer consider only what is best calculated to produce the largest possible profit.

For the present India requires encouragement to develop on natural lines and should not be forced by those in control of the railways to work upon a system neither suited to the people nor to the productions of the country. It has just emerged from that stage of civilization in which every village was a self-contained unit and produced almost the whole of its normal requirements. The change has been effected from the outside, through the intervention of a Government conducted on principles greatly in advance of the ideas preva-

lent among the great bulk of the population, but the Government are not in a position, except by slow degrees, to raise the people to their own level and from their efforts the best results will accrue if their influence is used to promote a natural development. The improvements in transport and the accumulations of capital in private hands have already greatly extended the possible sphere of industrial operations and our object should be to encourage a gradual change and not a complete revolution. The village has long since ceased to be a sufficiently large unit, but the area has not yet expanded indefinitely. It is larger in some parts of the country than in others, and generally as a rough average for many of the principal staple articles we may regard each revenue district as about the area which can be dealt with from a single centre. This would seem to indicate that the policy of allowing District Boards to levy a special railway cess for the promotion of local light railway projects is a very sound one and it is to be regretted that so far comparatively few districts have availed themselves of it.

III

THE LACK OF INDUSTRIAL ENTERPRISE

The apologist for British rule in India dwells with considerable satisfaction upon the rapid growth of the external trade of the Indian Empire, whilst the ardent advocate of swadeshism bitterly complains that the export trade is almost entirely in raw materials and the import trade in manufactured goods, and that consequently India is denied that measure of industrial life which is essential to the well-being of any nation. To a large extent it is the remarkable progress that has been made in providing facilities for transport, in constructing irrigation works and

in bringing waste lands under cultivation that has engendered the idea that in the interest of England a one-sided development has been a matter of deliberate policy. A careful review of the economic history of India during the 19th century, however, would dispel this idea and supply ample evidence to show that, in the main, as much progress has been made in every direction as could reasonably be expected. It would be foolish to deny that in minor matters a mistaken policy has been pursued occasionally and in respect to education especially a sufficiently long-sighted view has not been taken.

Indian industries have suffered considerably by competition with the imported manufactures of Europe, but at the same time a modern industrial system has been built up which, in part at any rate, compensates for the degradation or disappearance of the ancient handicrafts of the country. That the movement in both directions has not been much more pronounced than is actually the case is a matter for surprise. That the Indian hand-loom weaver, though hard pressed, still survives the competition of the power loom, that the Indian metal-worker holds his own against the productions of English and continental hollow ware-makers, that even the primitive methods of making gold lace still compete with the extraordinarily delicate and beautiful methods of Lyons, each and all indicate a surprising degree of tenacity on the part of the people of this country to maintain their primitive methods and hereditary occupations in the face of militant Western commercialism. Except in the cotton trade of Bombay the present industrial situation is the outcome of Western energy and Eastern inertia.

Education has at last become sufficiently diffused to set in motion new forces, to produce new desires and, in fact, to develop a not inconsiderable amount of kinetic

energy which, from lack of experience and knowledge, is being expended in fruitless efforts which can only generate friction and heat.

I propose to briefly review the situation and to enumerate some of the economic, as apart from the social, reasons why more has not been accomplished. Before the modern era of industrialism India was practically self-supporting and when trade sprang up between the East and the West, it was largely an export trade from India in manufactured goods in exchange for precious metals. The position was then the reverse of what it is now, save that then, as now, the carrying trade was in the hands of enterprising foreigners and the profits were proportionate to the risks, which in those days were very considerable. Transportation was expensive and the merchants grew rich. With the growth of the modern factory system a vast change has taken place, which has been accelerated and accentuated by the reduced cost of seaborne freight, the whole advantage of which has been reaped by India, since a much smaller percentage of the exports is now required to pay the cost of transportation. For a long time it was looked upon as natural, both in India and in England, that the raw products of the East should be exchanged for the manufactures of the West and it is only within the present generation that dissatisfaction with this condition of things has grown up and it is only recently that it has developed the intensity which is expressed by the *Swadeshi* movement.

The establishment of the *Pax Britannica*, at the beginning of the sixties, inaugurated a new era in India, and during the last 50 years there has been an immense amount of material progress. The population has increased by more than about 50 per cent. or from an estimate of about 200 millions in 1861 to upwards of 315 millions in 1911. The

external trade has in this same period increased over 270 per cent., from Rs. 4-4-0 per head to Rs. 11-8-0 per head. The improvement of agriculture is the line along which action is at the present time proceeding with the greatest possible energy and there is not the least doubt that it will be productive of immense development. Population is however growing very rapidly and may be expected to absorb a very large proportion of the extra food supplies so that, unless there be a material increase in the number of people employed in other than agricultural pursuits or a very large increase in the efficiency of those now engaged in such pursuits, there is not likely to be any rapid growth in the wealth of individuals. To secure increased efficiency of labour is, therefore, an object of paramount importance and this can be accomplished by education, by industrial development and by the scientific application of capital to the exploration of natural resources.

It is only in recent years that it has become urgent to take steps to create new fields for the employment of Indian brains and Indian labour, and even now it is mainly employment for the former that is a matter of urgency. There is no visible surplus of labour nor is there any prospect of such a surplus till new and more economic methods of employing labour are introduced on a very extensive scale and its efficiency so increased that part of it becomes available for new fields of activity. It is recognised that the standard of living among the labouring classes is much too low and it is equally recognised that there is but little prospect of improvement in this direction so long as the demand for Indian labour does not force the employers of labour to devote their attention to increasing the efficiency of such labour. Under the *laissez faire* policy which has dominated British administration, both in England and India, for the last

sixty years, great commercial interests have grown up in England dependent upon the Indian market and the country has been systematically exploited by British manufacturer with the acquiescence, if not the approval of the intellectual classes in India. The Government has looked with a friendly eye upon the ryot toiling in his field, but has treated with indifference the artisan laboriously fabricating the products of his skill by the primitive processes of his forefathers.

The administration of India under the Crown inherited to some extent the traditions of the old East India Company and treated with no great regard the European capitalist who endeavoured to establish manufactures in India. He was hampered by regulations, throttled by Railway freights and subjected to unsympathetic treatment throughout; with the result that there has not been the same energy employed in finding fields for industrial capital in India which has been exhibited in other parts of the world, by no means so favourably situated in respect to the primary requisites for industrial progress. A more liberal policy is now pursued but the old reputation remains and there is still a strong feeling that the British merchant rather than the British manufacturer is wanted in India. In certain directions the conditions have been so favourable that, even without official help, progress has been made, notably in Bombay which received a great impetus from the cotton famine of 1861-65 and was further assisted by the opening of the Suez Canal and the construction of the great railway nexus which has made it the chief commercial port of India. On the other side of the Peninsula the jute monopoly, the opening up of the Bengal coal fields and the extraordinary expansion of tea planting have materially contributed to make Calcutta, naturally the outlet of a vast hinterland, into one of the chief commercial

cities of the Empire. On the whole, though little has been accomplished Indian industries have not been neglected by the private merchant and now that attention is forcibly drawn to them, the difficulties surrounding the inception of new enterprises are perceived to be very formidable and sufficient to deter European capitalists from taking them up. If this be so, how can it be expected that inexperienced Indians, will succeed where Europeans have failed, or, at any rate, have been deterred. Nevertheless something must be done and there are certain favourable influences at work which, in course of time, will operate very powerfully, though hitherto they have not been of much account.

The reorganization of credit consequent upon the development of Co-operative Credit Associations will reduce the rates of usury and the money lenders and native bankers will be unable to offer such attractive terms to depositors as they have hitherto done, and, by degrees, small capitalists, finding land to yield too small a return upon the money invested in it, will begin to look at industrial ventures as outlets for the investment of their capital. The pressure of unemployment will drive educated Indians to embark on industrial work for less remuneration than would content Europeans of similar qualifications and Indian capital will perforce flow in directions which hitherto it has shunned. With help and guidance, for which he must probably look to Government, the small Indian capitalist should find a natural outlet for his energies and his funds in placing the indigenous industries of the country on an organised basis. From these small beginnings experience and knowledge will be gained which will be applied to more ambitious undertakings later on. The French have a proverb, *c'est le premier pas qui cout*, and the greatest difficulty which

has been experienced in the past, and which is likely to continue to prove a serious obstacle to progress in the future, is the pioneer work which has to be done. To start a new manufacture in India or to introduce improvements into one already existing calls for an outlay of capital, the bulk of which will be expended in pioneer work, and in most cases it will be impossible to recover this outlay without some kind of monopoly which will ensure time for the enjoyment of something more than the normal rate of profit which may be expected in settled industries. Where a patent can be obtained this difficulty vanishes, but usually patents are not obtainable as the processes are well-known and the special elements of risk in India are the adaptation of known processes to local conditions in respect to labour, raw materials, markets and, in some instances, climate. Examples of the latter may be found in tanning and glass-making where, in the former, the heat affects the raw material and in the latter the health of the operatives.

Modern manufacture is now so highly specialised that the whole Indian market is, in many instances, insufficient to keep a single properly equipped factory going and, in many cases, owing to the cost of transport, markets are restricted at most to a single Province. The cost of internal transport from a single centre in India is often much higher than the freights from Europe to the various Indian ports, as these are abnormally low owing to the inequality between the bulk and weight of the merchandise brought into India and that taken away.

The inception of a new enterprise in India generally involves a long and costly preliminary investigation, the results of which, when carried into practice, can no longer be concealed. It frequently necessitates the special training of workmen over whom no permanent hold can

be retained. Should any measure of success be met with, the pioneer instead of being able to enjoy the fruit of his labour is confronted at once with competitors who do not scruple to avail themselves of his work and his workmen.

A great obstacle to the success, and consequently a deterrent, of industrial enterprise is the absence of subsidiary or allied industries. Thus cotton spinning in Bombay suffers greatly in comparison with Lancashire from the absence of great engineering works devoted to the cotton trade and the Indian spinner is at a disadvantage from the fact that his base of operations is 7,000 miles away. The gradual growth of enterprise will to some extent remedy matters in this respect, but a country in which manufacturing enterprise must always be of a partial character can never wholly hope to overcome this difficulty.

Industrial operations in India, connected with the manufacture of the locally grown raw produce, suffer from the fact that the plant can only be kept going during the time the season's crop is coming in, or a big capital outlay of a very speculative character is necessary to purchase a sufficient amount of material to ensure continuity of operations throughout the year. Competition with industrial centres which can draw on the whole world for supplies and can obtain them at intervals throughout the whole year is, therefore, out of the question. It is for this reason that India can never hope to export flour or oil, but must always be content to dispose of its surplus wheat and surplus oil-seeds just as the crop comes from the ryot's hands. Further, in respect to oil-seeds the raw material is easily transported, but the manufactured product requires to be carefully packed in drums or casks and the freight on the same, owing to the extra storage space required and the more careful handling necessary, is

considerably greater. Again the wealthy countries of the West are much better markets, owing to the higher standard of agricultural practice, for such bye-products as bran, offal and oil cake.

The high quality of many modern products is often due to the fact that, they are produced by blending the raw materials from a variety of sources and, in the infant stages of Indian industry, it is obviously impossible to create the organisation necessary to obtain suitable supplies of raw material. Here it is all approximately of one class and 50 years of steady progress in the cotton trade have not sufficed to develop, to any considerable extent, the importation of raw materials of higher quality from other parts of the world. Lancashire, on the other hand, draws its supplies from every part of the world, and can without difficulty obtain exactly the raw material it requires to produce a specified class of yarn.

These are some of the disabilities under which India suffers in comparison with the manufacturing nations of Europe, and to a large extent, they account for the disinclination of capitalists to encourage manufacturing enterprise in India. The force of some will be weakened as local enterprise grows stronger, but those that are due to geographical position can hardly be remedied.

CHAPTER V

INDUSTRIAL ENTERPRISE

I

MADRAS TRADE RETURNS

THE statistical records published by Government in various departments throw a good deal of light upon the development of Indian resources and I propose to examine some of the records of the past ten years to ascertain not only the amount of material progress made in this Presidency so far as it can be expressed in figures but also to discover, if possible, the trend of the economic expansion which is undoubtedly going on. The first decade of the twentieth century has been marked by great activity in many directions and has culminated in a readjustment of the relations between the rulers and the ruled, in which the latter henceforth participate to a much greater extent than ever before in the control and direction of their own internal affairs. The spread of education and the consequent intellectual development of the people is in the main responsible for this change, and there is now a rapidly growing surplus of educated men for whom employment cannot be found in the ordinarily recognised channels. They must create new fields for themselves and their efforts so far have not met with any great measure of success ; there has therefore gradually grown up throughout the

country a strong feeling that Government should drop the *laissez faire* policy of the Victorian school of economics in favour of an active participation on the part of the State in industrial development.

That no narrow view of the functions of the State has prevailed in the past the railways and the irrigation canals provide ample evidence. They are responsible to a large extent for such material progress as has been made and the people, recognising the success which has thereby been achieved, and aware of their own weakness in the face of Western industrialism, are asking for assistance to develop their own resources and meet the competition to which a free trade policy exposes their initial attempts at manufacture on modern lines. There is a strong feeling throughout the country that the only remedy is a fiscal policy of an avowedly protective character, but such a policy is hardly likely to achieve the object aimed at. The State has done much for agriculture and contemplates doing even more ; it has done little for other forms of industry and there are powerful interests opposed to any change. In lieu of protective duties, which there is but little hope the Home Government will allow, I am strongly in favour of an energetic educational and industrial policy having for its object the fostering of industrial enterprise and the diversion of a fair proportion of the intellect of the country from non-productive to directly productive occupations. That India should remain almost entirely dependent upon agriculture no one can reasonably contend to be desirable and yet such is unquestionably the effect of the present policy of masterly inactivity in regard to technical and industrial education. The development of private enterprise in Bombay and Calcutta masks to some extent the inactivity of the rest of India and it is for this reason desirable that the statistics

relating to the Madras Presidency should be examined apart from those relating to the rest of India.

From the "Season and Crop Reports" issued by the Board of Revenue it appears that the average total area under cultivation in Government and Inam lands during the five years ending 1900-01 was 27.048 million acres and that in 1901-02 it was 28.423 million acres, whilst in 1909-10 the area had risen to 36.358 million acres ; that is to say, in eight years the increase in total cultivated area amounted to 28.2 per cent. In respect to irrigation the figures for 1901-02 are 6.135 million acres, and for 1909-10 they are 9.276 million acres, or an increase of 51 per cent. Possibly this large increase in the area under cultivation explains the growing cry which comes from all parts of the country regarding the scarcity of labour. During the period under review it is true that the population has materially increased but the area of land under cultivation has increased even more rapidly. At the same time the percentage of food grains (cereals and pulses) has fallen from 80.5 to 79 per cent, but this is a much smaller decrease than is currently believed to have taken place. The increase in the area under rice cultivation has been as much as 44 per cent, whilst the increase in the area under cotton and oil seeds has only been 30.7 and 23.4 per cent respectively. It is evident therefore that so far as the Madras Presidency is concerned there has been no serious movement in favour of the cultivation of industrial, in place of food crops. In regard to agricultural stock a quinquennial estimate is framed, and comparing that published in 1899-1900 with the statement issued ten years later, it appears that the number of mature cattle has increased from 10.671 millions to 14.615 millions, or by 37 per cent. That is to say, cattle have increased in number faster than the area under cultivation, but it is doubtful if this is a matter for

congratulation as there has been no improvement in the quality of the live stock. Experienced agriculturists are generally of opinion that there are far too many cattle already upon the land and that a diminution in their numbers accompanied by a marked improvement in quality would be of immense benefit.

In respect to the internal trade of the Presidency no statistics are available, but it is reasonable to assume that the same is developing since the internal rail borne traffic has enormously increased. For the external trade of the Presidency very complete statistical information is published every year and from the returns for foreign trade, for coasting trade and for rail borne traffic across the frontiers much useful information may be gathered. The following table shows the total volume of trade during each of the last 10 years and includes—

- (1) Foreign merchandise imported or exported direct.
- (2) Products of India and foreign merchandise imported or exported coastwise.
- (3) Rail borne traffic exported or imported across the frontiers.

The figures under (2) however unfortunately include coastal movements of merchandise between ports in the Presidency. These items should balance one another, as the coastal exports of one port are registered as the imports of another. They therefore do not influence the figures for the balance of trade and they form so small a portion of the totals that their inclusion is in no way likely to lead to false deductions.

Year.	Total imports in lakhs, ex- cluding trea- sure.	Total exports in lakhs, ex- cluding trea- sure.	Excess of ex- port over im- ports in lakhs excluding trea- sure.
1900-01...	2146	2472	326
1901-02...	2118	2247	129
1902-03...	1819	2451	632
1903-04...	1943	2628	685
1904-05...	2283	2675	392
1905-06...	2494	2866	372
1906-07...	2770	3113	343
1907-08...	2817	3325	508
1908-09...	3019	3300	281
1909-10...	3022	3336	314

It will be conceded that the figures in the above table are a record of steady progress, but it will be necessary to go into details to ascertain the directions in which that progress has been made. During the first five years of the period under review foreign exports amounted to 6,658 lakhs and during the second five years to 8,963 lakhs, an increase of 2,305 lakhs. For this increase the following items are mainly responsible.

Hides and skins	... 500 lakhs.
Yarns and textiles	... 64 do.
Articles of food and drink	... 740 do.
Cotton	... 401 do.
Oil seeds	... 301 do.

"Articles of Food and Drink" of the exports of tea are the most important, having increased from $32\frac{1}{2}$ lakhs in 1900-01 to nearly 116 lakhs in 1909-10.

Through Madras ports, however, a good deal of the trade of Hyderabad and Mysore passes and a large

deduction has to be made from Madras figures on this account. For instance, the average net imports by rail from 1906 to 1910 exceeded those from 1901 to 1906 for the following items by the amounts specified.

Hides and skins	...	259 lakhs.
Yarns and textiles	...	268 do.
Cereals and pulses	...	441 do.
Cotton	...	49 do.
Oil seeds	...	171 do.

Turning to the coastwise trade, the imports and exports for the quinquennium ending 1904-05 amounted to 2,426 lakhs and 2,459 lakhs respectively, whilst for the quinquennium ending 1909-10 the figures are 3,330 lakhs and 2,718 lakhs respectively. The rapid growth of the import trade as compared with the export trade is noteworthy and is mainly accounted for by the following items.

Cereals and pulses	...	660 lakhs.
Mineral oil	...	187 do.
Teakwood	...	69 do.

The principle items of increase in the export trade are—

Oil seeds	...	138 lakhs.
Cereals and pulses	...	28 do.
Yarns and textiles	...	26 do.

From the figures in detail for foreign imports into the Presidency, no evidence can be obtained to show that in the matter of manufactures there is any falling off in dependence upon Europe. During the first quinquennium the total imports were valued at 3,751 lakhs and during the second quinquennium at 4,810 lakhs, the increase being

1059 lakhs made up chiefly as follows.

Yarns and textiles	...	365	lakhs.
Metals and hardware	...	177	do.
Machinery	...	71	do.
Railway plant	...	93	do.
Apparel	...	42	do.
Provisions	...	25	do.
Sugar	...	35	do.
Glass	...	24	do.
Scientific apparatus	...	28	do.
Matches	...	20	do.
Paper	...	22	do.
Chemicals	...	18	do.
		—	
	Total	920	do.
		—	

This conclusion is substantiated by the industrial statistics regarding factories, mills and mines complied in the office of the Director-General of Commerical Intelligence, Calcutta. From the latest published figures it would appear that in 1904 there were in the Madras Presidency 132 factories worked with steam power and employing 45,019 hands, whilst in 1908 the number of factories had increased to 224, or by 70 per cent. but the number of operatives employed was only 58,531, an increase of 30 per cent. Of these new factories, 29 were rice mills, 26 ginning factories, 13 tile factories and 4 oil mills, all of which belong to a primitive type of industrialism. The textile industries have made some, but not much, progress during the decade. In 1899-00 the outturn of yarn was 32,252,000 lbs., and in 1908-09 it was 39,635,000 lbs. an increase of 22.8 per cent. For woven goods the figures of the corresponding years are 6,940,000 lbs. and 7,597,000 lbs. an increase of only 9.5 per cent.

The consumption of coal is a measure of commercial

activity and from the trade returns it is possible to obtain the figures for Madras after deducting the rail borne exports which chiefly go to Mysore. The following tabular statement gives the details for each year of the period :—

Year.	Imports by sea.		Rail Borne Imports.	Total Tons.
	Indian Tons.	Foreign. Tons.		
1900-01 *	215,656	5,423	—16,231	203,848
1901-02	241,266	3,403	31,433	276,099
1902-03	187,027	4,062	17,355	208,444
1903-04 *	241,296	4,509	—15,507	230,298
1904-05	313,578	6,730	17,471	337,779
1905-06	182,720	4,698	143,584	331,002
1906-07	284,767	9,813	64,361	358,941
1907-08	378,655	22,964	25,049	425,968
1908-09	382,425	30,192	104,578	517,172
1909-10	305,968	39,845	186,678	532,491
Total	2,732,358	130,913	558,771	3,422,042

It will be noticed that the consumption of coal has rapidly increased, and this is in the main due (1) to the substitution of coal for wood as a fuel and (2) to the increased demand for locomotive fuel consequent upon the very considerable expansion of railway traffic. For industrial purposes there is no evidence of an increased consumption of coal for generating power. Small steam engines have to a large extent been superseded by internal combustion engines using either gas generated from charcoal or mineral oils and petroleum residues. The increase in the imports of foreign coal is due to consignments from Australia and Natal and may be taken as evidence of the weakness of the Bengal export trade in coal.

This examination of the trade returns suggests the conclusion that the increase in the area of land under

* In these two years the exports by rail exceed the imports.

occupation and that the increase in the irrigated area are the two main factors which account for the progress of the last ten years. Of any industrial growth they reveal but traces and one is therefore compelled to rely on personal knowledge of what is going on throughout the country to formulate any general statements regarding the trend of industrial movements in Madras. A review of this information leads to the conclusion that European enterprise is stagnating, that organised indigenous effort is making little progress, but that there is a distinct tendency to an increased efficiency in individual undertakings. The diffusion of education, the Swadeshi movement, the work of the late Department of Industries and all the State aid afforded to Industrialism connoted by that department has led to a better appreciation of modern methods of working and to the use of modern tools in a small way. In this connection attention may be drawn to the not insignificant increase during the last five years of imports due to the growth of enterprise in the Presidency.

Machinery	...	...	71 lakhs.
Scientific apparatus	...	28	do
Chemicals	...	18	do

The general tendency may be indicated by the success which has attended the efforts to popularize the use of the fly-shuttle loom, to the growing demand for what may be termed rural factories, in which machinery driven by oil engines replaces the primitive labour of men and cattle, and to the enormous increase in and the more intelligent use of the coal tar dyes. By the development of agriculture, by the growth of improved industrial crops and by the extension of irrigation wealth has increased, and among the wealthier classes there has been a general elevation in the standard of luxury and convenience in modes of living. The general rise in price of agricultural

produce has brought increased prosperity to the land owning classes and the condition of the landless labourer has also improved consequent upon the fact that he is not tied to the soil, that he can move freely about the country, seeking a market for his labour where it is most in demand and emigrating from the country to foreign plantations where his labour commands high wages. New ideas are slowly permeating the mass of the population and the economic pressure due to improved means of communication with the rest of the world is bringing about a change in methods of production which may become of vast importance later on. There is ample evidence to show that labour is now too expensive to neglect labour-saving machinery and the immediate need of the future is the development of credit. The agricultural resources are immense, but the lack of credit is a serious obstacle to improvement and there is no direction in which the efforts of Government can be more wisely extended than in the creation of a sound system of agricultural finance. The movement in favour of Co-operative Credit Societies is a step in the right direction and it requires to be supplemented by efforts to establish co-operative working with the village as a unit. Village irrigation works and the village agricultural factory springing from a village Co-operative Credit Society are possibly dreams of a distant future, but the present condition of the people in this Presidency indicates that their realization would be attended with very material benefits.

II

INDUSTRIAL NOTES—THE GODAVERI AND KISTNA
DELTAS

The irrigated area in these two deltas now amounts to over $1\frac{1}{2}$ million acres, mainly devoted to the cultivation

of paddy, of which about one million tons valued at more than 5 crores of rupees is raised annually. Formerly nearly the whole of this crop was exported as paddy, but now a very large number of mills have been established and a large proportion, exactly how much I do not know, is cleaned and converted into rice before it is sent away. Sometimes the paddy is boiled before treatment in the mill when what is known as 'boiled rice' is the final production ; in other cases it is passed straight into the mill leading to the production of what is locally known as 'raw rice'. The earlier mills that were established in the towns generally consisted of two or three self-contained machines, driven by an oil engine. In Bezwada there are 19 such small factories in existence, but apparently they find it difficult to compete with the larger and better equipped plants which have been started during the last year or two and which are to be found scattered all over these deltas. These earlier plants were very crudely installed and many of them are driven by oil engines, which use kerosine oil instead of liquid fuel, with the result that the running expenses are thereby very considerably enhanced. The most recent type of mill is driven by steam, furnished by boilers fitted with furnaces capable of burning the paddy husk and that commodity, which was formerly looked upon as waste product, is now in considerable demand for steam raising purposes.

The new rice mills are not attractive looking factories being invariably constructed of sheets of galvanised corrugated iron and, to say the least, they are not an ornament to the landscape. They are practically all built on the same plan and the machinery used for hulling the rice differs only in detail in different factories. Where the paddy is first boiled, there are a number of iron kettles for this purpose; into which steam can be passed and there

is usually a large area of cemented floor on which the paddy can be subsequently spread to dry in the sun. When the paddy goes into the mill proper, it is passed over reciprocating sieves to remove stones, sticks and other foreign matter, and in some cases fans are used to draw a current of air through the layer of paddy which removes the dust. After this preliminary cleaning process, it is elevated to bins placed over the shellers or hullers. These invariably consist of discs of cast iron faced with cement mainly composed of emery. The paddy is fed through the eye of the upper disc, the lower being the runner. The action of these disc separates the outer coat or husk from the interior of the berry formed by the rice grains. A certain percentage of the paddy passes through without being husked and screens are necessary to remove the unhusked grains which are passed through the huller again. The brown rice from the huller is passed into a machine consisting of a conical drum mounted on a vertical spindle running at a high velocity. The drum is faced with emery and surrounded by a casing lined with steel wire cloth. The rice enters at the top and the space between the cone and the casing is adjusted to secure a sufficient rubbing action to deliver clean rice at the outlet from the machine. Where a fine quality of rice is required it is passed through a similar polishing machine, the cone being covered with sheep skin instead of emery. A polishing action is thereby secured which greatly improves the appearance of the rice.

The number of these factories is steadily increasing and already there appears to be considerable competition to obtain supplies of paddy. The ryots benefit by this, but it is doubtful if the managers of these rice mills are sufficiently versed in the fluctuations of market prices to

conduct their business on altogether sound lines. The earlier mills were very profitable to their owners, but it is reported at the present time that competition has already greatly reduced the profits that can be earned by rice milling. The capital invested in these mills amounts, in the aggregate, to a very large sum, but the fixed charges of each individual plant are by no means a heavy burden and when prices are unfavourable they can shut down and wait for better times. There is, of course, nothing in this part of the country that can compare in size with the large rice mills in Rangoon, but even over there the small man is able to hold his own against the mammoth concern, owing to the fact that he is not always bound to be running and that he need not run at a loss.

The high prices which have been realised for paddy during the past few years have rendered its cultivation very profitable and there has consequently been a rapid extension in the area under the delta canals. Large tracts of land, however, are at too high a level to be commanded by the canals and flow irrigation is not possible. There is also a large area of low lying land at the tail end of the irrigation channels, to which a supply cannot be given from the canals because it is all utilised before it reaches these tail ends, and in the Kistna Delta, at any rate, it is deemed inadvisable to provide specially for these lands as the area under irrigation is already nearly as much as the river in its natural condition can supply. In the Kollair Lake, which is an unfilled depression between the two deltas, and in the drains, both natural and artificial, by which the surplus water of the delta is removed, there is usually throughout the irrigation season an abundant supply of water, but both in the lake and in the drains it will be necessary to lift the water several feet to enable it to flow over the land.

Nineteen years ago I started the first steam pumping station at Mattugunta on the banks of the Upputeru and in the following year a second one was started at Kollita Kota Lanka in the Kollair lake by a Guntur firm. Still later an experimental pumping station was established on the Divi Island which ultimately resulted in the Divi Island Pumping Project, which has now been at work so successfully for the last 4 or 5 years. This irrigation pumping scheme is the largest in the world of its kind, but I do not now propose to describe it as these notes are only intended to refer to private enterprise. The steam engines and pumps erected on the Kollair Lake did not prove a brilliant success and when the superior merits of oil engines as a source of motive power were demonstrated, it was not long before the riparian owners round Kollair began to utilise them for the irrigation of their lands. At the present time there are 13 installations in the Kollair Lake, of which only one is driven by steam. The oil engines aggregate 290 horse power and the area under irrigation is 3,000 acres. In no case is the lift more than a few feet. The majority of the installations are badly designed, the principal defect being that nearly all the engines are much larger than is necessary for the work to be done and most of them are old patterns which do not work with anything like the economy obtainable with engines of later construction. Amateur engineering is very much in evidence, and the remodelling of these pumping stations would lead to a very considerable economy in working expenses.

The canals taking off from above the anicuts at Bezawada and Dowleshwaram run for a considerable distance in deep cuttings, and it is only some miles from their heads that direct irrigation becomes possible. It is further to be noted that the high level canals bounding the edges of the

delta irrigate but a small tract on the side away from the delta, as on this side the land slopes towards the canal. Some of these lands are very fertile, others are saline and waste and the success of irrigation by pumping has led to several combinations of ryots who have obtained permission to pump water from the Government canals. In the Kistna district there are at present four installations which are allowed to take water from the canals for an area of 1,800 acres. The Atmakur installation was the first put down and may be taken as typical. The water has to be lifted 7 or 8 feet and the area originally sanctioned was 500 acres. The motive power consisted of two 12 H. P. Hornsby engines, driving two 10" centrifugal pumps. Subsequently permission was given to extend the area to 800 acres, and this year we have installed a 28 B. H. P. engine and a 14" Rees Roturbo pump. The ryots, for these earlier installations, have been permitted to take water, paying only baling rates for the same, but in future it is quite certain that if any further extension of this kind of irrigation is found feasible the full water rates will be charged. The total cost of pumping is probably from Rs. 10 to Rs. 12 per acre and the keenness with which ryots are prepared to take water for pumps is evidence of the extreme value of the same.

I have already mentioned the possibility of pumping from drains and reference may be made to the enterprise of Mr. K. Hanumantha Row of Masulipatam who has devoted himself to reclaiming large tracts of land. He has at present three pumping stations at work and a fourth, consisting of a 40 H. P. Crossley Suction gas plant and gas engine, driving a 12" and a 10" Rees Roturbo pump, is now under erection and when complete will lift enough water from the Dyyappa Kalava to irrigate about 450 acres of land. Another installation of a similar character but

somewhat smaller is being erected for the Zemindar of Devarakota. So far I have dealt with completed projects for irrigating by pumping, but there are several other proposals in the air some of which relate to very large areas and ultimately, especially in the Godaveri district, we may expect to see a great development of irrigation by pumping.

In the upland tracts of these districts there is, in many cases, so short a supply of water that difficulty is experienced in getting even enough for domestic purposes. Recently a considerable number of borings have been put down at the bottom of existing wells and some of these have tapped fair supplies of water which have proved a great convenience to the villagers. Applications for borings are therefore very numerous. The Zemindar of Devarakota has recently purchased a steam drilling set and is now engaged in making borings at Sivagunga, near Masulipatam. At the time of my visit the bore-hole had reached to a depth of 250ft. and several abundant supplies of water had already been tapped at various levels, but unfortunately in each case the water was brackish. With increasing depth the quality of water has, however, improved, and it is hoped that at a still greater depth a supply of suitable water may be obtained. The drill was an expensive tool as it cost about Rs. 7,000, but it has proved an extremely effective instrument having already penetrated more than 50 ft. below the maximum depth that was ever reached by hand tools in the neighbourhood.

Turning to purely industrial matters, the Zamindar of Polavaram has erected a saw mill and a small ginning factory at Cocanada driven by a 36 H. P. oil engine and he assures me that it is turning out a very profitable investment, though from some mistake in the original calculations it has proved impracticable to work both the saw mill and the gins at the same time.

The most remarkable industrial development in these districts is, however, that of the aluminium industry in Rajahmundry. There is no particular reason why the industry should be located there and its successful establishment is entirely due to the enterprise of the people in that town. It originated after the Cocanada Exhibition held about 10 years ago when great interest was displayed in the exhibits of the then Government Aluminium Department. At the present time there are at Rajahmundry between 20 and 30 small factories employing about 600 men and turning out goods worth several lakhs of rupees a year. The recent fall in the price of aluminium has given the business a great impetus and as the metal is now much cheaper than brass it is commonly used by even the poorest classes of the community. All the work is done by hand, and though the articles are roughly made they are very serviceable. Detailed inquiry shows that though the industry has grown very rapidly during the last two years, the profits to owners of factories are comparatively small, as through excessive competition amongst themselves to get new business they have cut down the prices to a level which leaves them an exceedingly small margin of profit. To remedy matters they have had recourse to purchasing supplies of continental metal of a lower standard of purity than experience has shown to be desirable. Aluminium cooking pots in India should be of the highest standard of purity commercially procurable so that they may withstand for a reasonable time the corroding effects of the acid and saline food-stuffs common amongst people. If the Rajahmundry utensils exhibit an undue tendency to corrode the demand for them will rapidly fall off and their business will suffer. The Indian Aluminium Company have, however, taken the matter up and are arranging for

large supplies of the best metal to be available on very favourable terms. Apparently it is their policy to regard the Rajahmundry factories as coadjutors rather than rivals. They are serving to spread a knowledge of the metal and its valuable properties throughout the country, which I think cannot but tend to increase the demand for their own more varied and better finished manufactures. Judging from the extensive use to which Aluminium is now put in the Deltas and the Northern Circars, the prospects of the industry are of an extremely rosy character and it seems likely that within a few years the demand for the metal in India will be so large as to fully justify the establishment of works in the country for its manufacture from the abundant supplies of suitable ore which, the Geological Department state, exist in various parts of the country.

It has naturally been impossible in these notes to go into any detail and they will have served their purpose, if they create an impression that in these districts there is a considerable amount of industrial activity, still of a primitive type, but working on fairly sound lines and likely in the future to develop. The people are accumulating experience, and although the nature of their environment will probably restrict their efforts to a large extent, progress and improvement will continue. The great danger to be faced is excessive competition due to the restricted opportunities available, and it is important that every effort should be made to devise new outlets along which capital and enterprise can flow.

III

INDUSTRIAL NOTES—MADURA

Excluding Madras, Madura has the largest population and is probably the wealthiest town in this Presidency. In 1871 the population was returned as under

52,000 and according to the recent census it is 132,699. The town is in a notoriously insanitary condition, largely due to overcrowding, as the population is growing very much faster than the number of houses. The recent epidemics of cholera and small pox are said to have carried off nearly 2,000 people. Whether this is an exaggeration or not, there is no doubt that the epidemics were very severe and point to the urgent necessity for improved methods of sanitation I mention these matters as a prelude to my notes upon the industries of the town, as the growth and development of industrial life must largely be affected by the surroundings in which it is carried on.

The commercial prosperity which Madura now enjoys is largely due to the efforts of two men—the late Col. Pennycuick, R. E., who brought the waters of the Periyar into the country to the immediate north of Madura and to Mr. L.K. Tulsiram, who introduced the modern methods of dyeing now carried on by so large a proportion of the population. The Periyar waters irrigate nearly 150,000 acres and have enormously increased the resources of the district. The land was formerly dependent on a large number of rain-fed and river-fed tanks, the supply to which was extremely precarious. All this has now been changed and with unfailing certainty the cultivators of the Periyar lands can rely upon receiving an ample supply of water soon after the burst of the South-west monsoon. Col. Pennycuick served for over 30 years in the Madras Presidency and the Periyar irrigation is a lasting monument not only to his engineering ability but also to his force of character and strength of will, for the inception of the work in the Travancore hills was a desperate struggle against adverse natural circumstances. Madura owes much to his genius and resource and it would be a graceful act on the

part of its citizens if they took steps to express their gratitude in some permanent memorial.

The part which Mr. Tulsiram has played in the industrial development of Madura is modestly described by him in a note which he submitted to the Industrial Conference at Ootacamund. He says : "The origin of the industry in Madura dates from the casual visit to Madura of a student of Professor T.K. Gajjar of Bombay, who explained to me the method of dyeing cotton yarn with alizarine on a large scale. I then visited the dyeing laboratory of the Badische firm at Bombay and developed the industry." To what extent the industry has expanded in the last ten years may be gauged from the figures relating to the imports of alizarine into Tuticorin, the whole of which is used in the Madura dye works. In 1901-02 they were valued at Rs. 1,51,519 and in 1910-11 at Rs. 5,26,795. Besides alizarine, other dye-stuffs are now beginning to be used and for the dye trade of Madura about 2,000 bales of cotton, each weighing 400 lbs., are required per month: that is to say, the annual production of dyed yarn now amounts to about 10 million pounds. It is exported to all parts of the Madras Presidency and in steadily increasing quantities to places beyond the Presidency. The typical shade is a brownish red, not a particularly good colour, but one which suits the taste of the people. This industry is remarkable not only for its extremely rapid growth, but also for the fact that it is in the hands of a very large number of individual dyers, none of whom are working on a very large scale. It is an excellent example of indigenous industry adapted to modern conditions. The dyers are by no means experts in their trade, but they know how to produce the particular shade required by the market. For some years past, the more intelligent among them have been asking for the provision of technical instruc-

tion and it is now probable that, within a comparatively short time, a tinctorial laboratory and an experimental dye house will be established which will afford the chemical and technical knowledge which the dyers recognise they are in need of.

At the present time there is only one spinning mill in Madura, but for many years past it has enjoyed a considerable measure of prosperity, owing to the local demand for its yarn. The mill contains over 35,000 spindles and to it is now being added a second and much larger mill which, when it is complete, will be fitted with nearly 75,000 spindles and the two together will probably provide employment for between 5,000 and 6,000 hands. A small spinning mill to contain 3,000 spindles is also being erected by a native of the town, Mr. S. Ramier, and it will be interesting to see whether he is able to make a commercial success on a small scale of an industry which is usually associated with big capitalists and a large output. The conditions are favourable for the experiment, but I am afraid there can be but little doubt about the result.

Madura has long been celebrated as a great weaving centre and the industry to-day seems to have been but little affected by the competition of imported piece-goods. Both silk and cotton are extensively woven and the bulk of the production takes the form of solid bordered cloths, which cannot at present be woven in power looms. It is difficult to say how many looms are at work in the town. The Imperial Gazetteer states that the number is about 2,000, whilst the census returns of 1911 show that there are over 16,400 persons engaged in the weaving of silk and cotton goods. In the manufacture of these bordered cloths large quantities of silk and gold thread are used. The latter is all imported from France. Formerly, it was a local industry and there

seems to be no reason, except lack of enterprise why under modern conditions it should not again be revived. One of the most interesting industrial sights of the town is the Meenakshi Weaving Factory where, in a large hall, about 150 looms have been erected, all of which are engaged on the manufacture of bordered cloths. Some years ago an enterprising weaver in the town introduced some important modifications into the method of arranging the harness whereby the patterns along the borders are produced. His invention was patented and being of some practical value was largely taken up and used. An attempt to levy a royalty led to extended litigation which ended in the upholding of the patent, but it is doubtful if the unfortunate patentee has derived anything but worry and vexation from his attempts to develope the use of his invention.

From these notes it will be seen that Madura is essentially a cotton town, the mill trade being in the hands of a European Company, but the dying and weaving trades entirely in the hands of the natives and run very successfully on more or less indigenous lines. For many years past, the District Board maintained a fairly efficient industrial school, which, curiously enough, confined itself to work in wood and metal and entirely ignored the two great indigenous industries of the town. A year ago it was taken over by Government and a scheme is now under consideration for converting it into a really living technical and industrial institute, to be intimately associated with the industrial enterprise of the neighbourhood.

The chief object of interest in Madura is the great temple dedicated to the Goddess Meenakshi. The Devastanam Committee have recently sought our assistance in regard to the insanitary condition of the Pottamarai, or the Golden Lily tank, in which all the pilgrims bathe on

festive occasions. The tank is of considerable area and deep enough to communicate with the water bearing sand that underlie Madura. We have installed a 24 H. P. gas engine and Suction Gas plant to drive a 6" centrifugal pump and daily the water level in the tank can be lowered from 2 to 3 feet a fresh supply of water coming in from the sands below. This constant renewal of the water will enable the temple authorities to keep the tank in a thoroughly satisfactory condition. The large volume of water removed daily will be used to irrigate the gardens round the temple and the surplus, if there is any, will be carried by an existing culvert to the Elukadal or Seven Seas tank. The pumping plant need be at work only for a few hours every day and it is proposed to utilise the available power in the evenings to drive an electric plant to light up the temple. The plant is not sufficient to effectively light up the whole place, but it will provide current for 400 incandescent lamps, which will be a great improvement on the present system of oil lighting.

In the development of Madura cheap motive power would be of great advantage as coal is expensive and though the forests of the district can be made to yield a large supply of firewood, yet, as the cost of bringing it into the town is considerable, they can never be regarded as an altogether satisfactory source of supply. Within 70 miles there is available, during the irrigation season, a vast amount of water power at the outlet of the Periyar lake. By a comparatively slight modification of the principles upon which the water is at present distributed it would be possible to arrange for a perennial supply sufficient to yield 20,000 horse.power for twelve hours per day. The scheme has not yet been approved of by the irrigation authorities of the Government of India as they are reluctant to admit of any interference whatever with what they

consider to be the paramount claims of irrigation. It is certainly however merely a matter of time before this valuable source of water power is made practical use of and if it is ultimately found feasible to arrange for a perennial flow of water from the lake it will enable Madura to be supplied with what is now an unduly costly item in any manufacturing operations carried on in the town.

A subsidiary advantage attaching to any scheme for supplying Madura with power would be the perennial supply of water which would become available for the irrigation of such crops as sugarcane, which require water all the year round. A 20,000 horse-power scheme would also enable 20,000 acres of the Periyar irrigated tracts to be converted to sugarcane cultivation and this area would ultimately yield a much larger revenue and would be to the district a much greater source of wealth than it now is, while yielding only a single crop of paddy. The Periyar water is devoid of silt and carries no fertilizing material to the fields. It is consequently necessary to supply manure in large quantities. This is a source of great difficulty to the ryots and ultimately it is certain that they will be driven to the use of artificial manures. Possibly the electric energy which can be obtained from the Periyar water may be of assistance in solving this problem. There is no doubt that nitrate of lime could be manufactured comparatively cheaply and in very large quantities, but it is doubtful if that alone will be sufficient to maintain a uniform standard of fertility in the Periyar tract. The manure question is one of great importance and well worthy of study by agriculturists and chemical engineers.

During the last year or two much interest has been evoked by the remarkable success which has attended the cultivation of what is known as Cambodia cotton. With a

slight amount of irrigation this species of cotton yields extraordinarily large crops and the bolls are of very high quality. Already thousands of bales have been put on the market and there is a demand in excess of any possible supply. Although the land in the immediate neighbourhood of Madura is not favourable for cotton cultivation it lies in the centre of an immense district in which this Cambodia cotton can be largely grown. The necessity for irrigation restricts the area under cultivation, but it will encourage the development of well irrigation and as the profits are extremely large it is probable that a diligent search for water will be made and that numerous small pumping plants will be installed to deal with supplies lying at a much greater depth than those which have hitherto been deemed of any practical value.

The minor industries of Madura are in a flourishing state. There is enterprise in every direction and wages of late years have risen to abnormally high figures. With or without a supply of electric energy Madura bids fair to become a great industrial city and it behoves those who are responsible for Municipal administration to take long sighted views of the requirements of the town and to provide for its expansion on sound and well considered lines.

IV

WELL IRRIGATION—COIMBATORE.

In the Season and Crop Report for 1908-09, I find it stated that in the Coimbatore District there are 75,290 wells in repair and 8,670 wells out of repair and not used. From these wells water was obtained for the irrigation of 302,703 acres, which is equivalent to an average of 4 acres of irrigation under each well. It is a noteworthy fact that there are nearly as many wells in the South Arcot district, but they only irrigate

83,790 acres, or an average of 1.2 acres per well. Yet the average rainfall of the Coimbatore district is only 25.65 inches against an average rainfall of 46.40 in South Arcot. The total area under well irrigation in the Presidency in 1908-09 was 1,322,05 acres, so that Coimbatore alone accounts for 23 per cent. of the total.

It is not difficult to explain the development of well irrigation in a district at first sight singularly devoid of natural facilities for the storage of subterranean water. Unquestionably the low rain fall and its precarious distribution, combined with the fact that only a very small proportion of the land could be irrigated by channels or tanks, has compelled the people to resort to well irrigation to an extent unknown elsewhere. In the Coast districts there are extensive beds of coarse sand which can be made to yield, without difficulty, very large supplies of water, but in Coimbatore there are none of these sandy deposits and the wells are almost invariably deep holes in the ground, into which the water percolates from the surrounding strata. The large supply of water, yielded in many of the wells, is due chiefly to the thickness of the layer of decomposed or partially decomposed rock which overlies the gneisses forming the bedrock of the great central plain, bounded by the Nilgiris on the north and the Anamalais and the Palnis on the south. Besides the wells irrigating the dry lands there are reported to be 3,140 wells which are used to supplement the irrigation of the wet lands. The records of the past century or more show that the ryots of Coimbatore have steadily pinned their faith on wells as a source of water for the irrigation of garden crops and we shall not be greatly in error in assuming that there are now 80,000 wells in the district (including the Karur taluk lately transferred to Trichinopoly.)

The typical Coimbatore well is a rectangular hole

dug in the earth which is usually hard enough to stand without much protection in the way of revetment or walls. It penetrates through the soil and sub-soil to the disintegrated rock below and is continued to such depth, as the resources of the owner permit, or till a sufficient supply of water has been obtained. There is no permanent water level. It varies from month to month and is usually highest in November or December and lowest in June or July. The range may be a few feet, but it is usually about 20 feet and sometimes more. As a rule, the wells do not exceed 40 to 45 feet in depth and the great majority yield water all the year round ; that is to say, they penetrate to some distance below the level of permanent saturation and we may take it that the water supply in the wells of Coimbatore could be considerably improved if every well was sunk an additional 10 or 20 feet. Naturally the wells vary very much in size, but they nearly always cover a large superficial area and form deep reservoirs in which the percolation water is stored all night to be removed the next morning. These wells represent a vast expenditure of human labour and if they were constructed at the present day they would involve an outlay of many crores of rupees. Every year the ryots of Coimbatore spend several lakhs of rupees in improving their wells and they now represent an asset of extreme value.

From information which has been kindly placed at my disposal by Mr. J. K. Lancashire, the Special Settlement officer, I find that in regard to 65,547 wells, about which certain items have been tabulated, they are fitted with 105,311 water-lifts ; that in 3,153 wells there are 3 mhotes, and in 1,177 wells 4 mhotes or more. The average area irrigated per well is about 4 acres and the average area irrigated per mhote about $2\frac{1}{2}$ acres. Well irrigation goes on all the year round and special cattle

have to be kept to work the mhotes. The cost of keeping these cattle varies a great deal and much of it is paid for in kind. It will be within the mark to estimate the monthly expenditure on a pair of average cattle at Rs. 15 ; that is to say, it will cost Rs. 180 per annum for the irrigation of $2\frac{1}{2}$ acres of land ; which means, the cost of irrigation per acre is over Rs. 70. This is merely an average figure and in many places, where the wells are deep, the cost of irrigation is considerably more and rises to over Rs. 100 per acre per annum. Nothing but a very intensive system of cultivation will stand such a heavy charge and the garden cultivation of Coimbatore is universally acknowledged by agricultural experts to represent the perfection of empirical methods.

The area under well irrigation is over 3 lakhs of acres and an annual charge of Rs. 70 per acre means that this well water supply costs the Coimbatore district something like 2 crores of rupees per annum. The burden is a heavy one and is felt more and more, as prices rise and currency transactions become commoner. Many years ago Mr. Robertson, the Principal of the Saidapet Agricultural College, promised a saving of 20 lakhs a year if the people would use his double mhone but they would have none of it and I think they were right. The ryot understood better than the scientific expert how to get work out of cattle. I made some inquiries into this matter some years ago and came to the conclusion that we could not materially improve the ryots' methods of lifting water and I should have ceased to concern myself with the problem of lifting water, but for the fact that in the oil engine and centrifugal pump modern scientific engineering has placed at our disposal something entirely outside the range of experience of the ryots. With properly designed plant of this kind the cost of

liting water is reduced to from one-third to one-fourth the cost of doing it by cattle. This fact is slowly becoming recognised and there are to-day several hundred oil engines and pumps at work in the south of India, and in the Coimbatore district I have records of about 30 such pumping installations.

The smallest scale, on which these are erected at present, involves the employment of a 3" centrifugal pump which will deliver 10,000 gallons of water per hour, driving it by an oil engine of power proportionate to the height the water has to be lifted. Centrifugal pumps, of smaller size than this, are machines which have to be run at a very high speed and are extremely inefficient. The 3" pump is the smallest size that can be used with efficiency and it is unfortunate that it is so large, as it is equivalent to at least four mhotes worked with the very best cattle in the district and it is evident that unless smaller outfits for pumping can be designed the application of mechanical methods of raising water is limited to wells which have a large water supply.

From the figures given me by Mr. Lancashire, which I have quoted, it appears that between 6 and 7 per cent. of the wells are fitted with three or more mhotes and assuming, as is only reasonable, that there is, during the agricultural season, sufficient water in these wells for three mhotes to be constantly occupied in lifting it out; then our experience suggests that in all these wells it would be to the advantange of the ryots if they could replace their mhotes by small pumping plants. As there are now approximately 80,000 wells in the Coimbatore district this means that there is a field for the employment of 5,000 pumping plants. The average cost of each plant may be taken as Rs. 2000 and the total expenditure would amount to one crore of rupees: Probably an average

of 15 acres per well or 75,000 acres of cultivation could be brought under the pumps and it will be safe to calculate upon a saving of Rs. 40 per acre in the cost of lifting water, or a total saving of 30 lakhs of rupees. Not only this, but the introduction of such plants would lead to great improvements in the wells, as at comparatively small cost they could be deepened very considerably and a much larger quantity of water obtained from a somewhat greater depth. If it pays now with cattle to lift water from a depth of 40 ft. it will certainly pay to go to a depth of 100 ft. with pumps. All that is necessary is that the plant should be of suitable design and unaffected in its working by variations in the water level.

Apart from its large capacity the centrifugal pump does not altogether meet other important requirements and for sometime past we have been experimenting with power driven pumps of the loose piston type. Driven with small engines of only 2 or 3 H. P. these pump can be conveniently arranged to work on lifts of 40 or 50 feet and to discharge from two to three thousand gallons of water per hour ; that is to say, they will do as much work as two mholes and can be worked twice as long per day which makes the engine equivalent to four pairs of cattle.

I have already stated that there are about 30 pumping stations in the Coimbatore district. Some of them were put down several years ago, and it is satisfactory to note that no less than ten have been put down in the last 12 months and that there are a number of new proposals under investigation. We may claim that the value of engines and pumps is fairly well recognised and that the only bar to progress is the inability of the ryots to obtain sufficient command of capital, to enable them to purchase them. Obviously Co-operative Credit

Societies cannot help the man who wants a loan of several thousand rupees. I have shown that at least a crore of rupees could be invested in engines and pumps in this district and that it would, on a very moderate estimate, effect a saving in the cost of pumping of at least 30 lakhs of rupees a year. It is really a matter for financiers to deal with. There is a field for the employment of a large amount of money. On a large scale the risks are negligible and the profits certain.

To some extent Government have provided funds under the Land Improvement Loans Act and it is a pity that more general use is not made of the Act. The terms offered are extremely liberal and the unpopularity is largely due to administrative friction. There is no question that in the next few years large sums of money will have to be found for the provision of machinery for lifting water for irrigation and it is equally certain that no one can provide the money on such favourable terms as Government. What is wanted is a simpler system of administering the Act, and of power to take the improvements effected by the loans into account as part of the security for the loan. On the other hand, the rate of interest might well be increased to 8 or 9 per cent. and the term of the loans shortened so that they may be repaid within 7 years. The interest and the instalments should be collected after the crops have been sold and when the man can pay without having recourse even temporarily to local money lenders. Finally, the profits on the working would enable a competent engineering staff to be maintained to supervise the erection of the plants and the maintenance of those already in existence in thoroughly good working order. This is now being done by the Pumping and Boring Department, but the installations are so few and are scattered over so wide an area that

they are not inspected as often as is desirable. We have already accumulated sufficient experience to carry out satisfactorily the preliminary investigations previous to the installation of a plant and there is in my mind no doubt whatever that a very large amount of money can be safely invested in providing machinery for lifting water out of the Coimbatore wells. The initial difficulties have been got over and it will be quite feasible now to spend a lakh or two lakhs a year on this work and as time goes on gradually increase the amount till the district is properly supplied with engines and pumps.

The well irrigation in Coimbatore is responsible for a considerable area under sugarcane and the district enjoys the advantage of two crop seasons. In most cases it would not be difficult to arrange that the engine driving the pump should also be available to drive a sugar mill. The crushing of cane imposes a severe strain on the ryots' resources and the extensive employment of power driven cane crushers would go far towards solving the sugar problem in this country. Although the total areas under sugarcane in the district is less than 9,000 acres there are a considerable number of villages possessing large areas under sugar-cane, and from information kindly supplied me by Mr. Lancashire I find that six villages have each over 250 acres of sugarcane cultivation. It may be interesting to give their names and the areas under cultivation. They are :—

		518	acres.
Singanallur	...	280	"
Kunujamuttur	...	282	"
Alangiyam	...	305	"
Oddarpalaiyam	...	1513	"
Budinattam	...	251	"
Sholamadur	...		

In each of these villages it will pay to put up a fairly

large sugarcane crushing mill with a modern evaporating plant for the manufacture of jaggery. In each case there would be, within a mile of the mill, more than sufficient cane to keep the plant working day and night through the whole of the two cutting seasons. The expenses of running the mill would be light and the ryots would be saved the whole of the work of converting their canes into jaggery. It seems to me that the establishment of these mills is obviously work that should be taken up on a co-operative basis, but it might perhaps be advisable that Government should establish one to demonstrate its advantages. The cost of such a plant may be taken as Rs. 10,000. Personally I believe it would be an excellent opportunity for any one who has that amount of money at his command and also possesses sufficient tact to gain the confidence of the ryots, upon whom he would be dependent for supplies of cane. I should prefer to see such mills established by the ryots themselves rather than that the ryots should be exploited by private capitalists, but the second alternative is preferable to the present state of affairs under which the area of sugarcane cultivation is restricted by the limited resources of the ryots in the two vital matters of water supply and cane crushing capacity.

CHAPTER VI

INDUSTRIAL LEADERS

I

INDIAN TECHNICAL STUDENTS ABROAD

INDUSTRIAL Development in India is seriously hampered by the difficulty which those, who wish to take part in it, find in acquiring the preliminary technical knowledge and practical experience which are essential to success in this direction. The facilities in India for technical education are of a very meagre character, but till the Swadeshi movement gathered force, it could not be fairly said that they were unequal to the demand. There are four Government Engineering Colleges, which, though they no longer solely train students for the Public Works Department and do not confine themselves to instruction in what is broadly termed Civil Engineering, are quite unable to meet the demand for miscellaneous technical knowledge which is now in evidence. The history of technical education in India reveals the fact that there has only been a demand for technical education when it has been evident that there was a demand for the services of technically trained students. Within the last few years, however, there has been a marked change in the attitude of the educated classes towards technical education. There is now a demand for such education, not to qualify for existing vacancies but to provide men capable of developing existing industries and pioneering new ones.

I am not now concerned to trace out the causes

which have brought about this remarkable change in the attitude of Indians towards what may be termed practical education. At the bottom, the causes are economic and the Swadeshi movement owes such vitality as it possesses to its economic origin, but it has been stimulated into unhealthy activities by imparting to it a political character. Hundreds of young men are encouraged to expatriate themselves for a term of years in the hope that when they return they may be qualified to engage in industrial work, to start new industries and to carry on manufacturing operations in competition with the imported products of the West. The need for industries to absorb the surplus energies of the unemployed educated classes is obvious, but the prospect is not an alluring one and the best intellect of the country still follows along beaten tracks and devotes itself to unproductive forms of employment. There is a slight element of unreality, one might almost say of burlesque, obvious in the attitude of the Indian Technical students one meets abroad. They are prone to indulge in mock heroics and weave unsubstantial day dreams in which the dreamer appears as a triumphant pioneer against the overwhelming commercialism of the foreign trader. The political element does the students no good and gives a bias to their studies which carries them wide of the mark.

The efforts now being made to promote a modern indigenous industrialism are worthy of the highest possible commendation but that should not prevent the candid friend from criticising them. I am, therefore, tempted to enquire whether the means employed are wise and in fact whether the object aimed at will be secured. It was at the Simla Educational Conference in 1901 that the question of technical education came under review, and a recommendation was made to the Government of India to grant

scholarships to deserving students to enable them to go to Europe or America. This Resolution was accepted and the Government of India Technical Scholarships were established.

Somewhat unexpectedly the idea of going abroad for technical education found favour and funds were raised by political associations, by philanthropic bodies and by private effort to send students to Japan, to England and to other places in order that they might obtain the necessary knowledge to render their country free from the industrial supremacy of Western nations. Japan pursued a somewhat similar course 30 or 40 years ago and the results of introducing Western civilisation, Western methods and Western ideas into Japan have been truly astonishing. India, it was thought, might score a similar success by using like methods. Accordingly Japan was asked to extend to India a helping hand and many students were sent there. The language difficulty was scarcely considered, the character of the Japs was imperfectly understood, but it was known that Japan had already achieved what India hoped to accomplish and the royal road to success was to study Japanese methods on the spot. I do not know that these young Indians were welcomed in Japan, but at any rate they were admitted to the Colleges and allowed to attend the lectures. Living was cheap and the atmosphere compared to the steamy plains of Bengal was exhilarating, but the language proved to be a more serious trouble than was anticipated. The Japanese did not eagerly impart the secrets of their success and the students made no progress. The modern workshops of Japan are rigidly guarded from prying eyes and Indian students had to content themselves with occasional glimpses of the inimitable methods of the artizans. Unfortunately that did them very little good and they have returned to India

no better prepared for Industrial work than when they first started.

The idea of sending students to Japan has accordingly been dropped and the technical schools of England are now regarded with more favourable eyes though the expensive English training is a serious matter. Twice during the course of my recent furlough, Mr. J. H. Reynolds, Principal of the Manchester Municipal School of Technology, enabled me to meet all the Indian students who had come there from various parts of India. There were between 40 and 50 of them in this one Institution, some with Government of India Scholarships, some paying their own way and the rest supported by funds subscribed by the public. Many of the students were in difficulties of one kind or another regarding their future prospects and they were all beginning to realise their deficiencies and the fact that the school courses must needs be supplemented by practical work before the training could in any sense be considered complete. To get this training they were unable and those, at the end of their time, did not look forward to facing the future in India with equanimity. I could give them little encouragement and no real help as they wanted employment in English factories and workshops where they could gradually acquire a practical knowledge of workshop operations and business methods, without which it is hopeless to engage in established industries and futile to attempt to start new industries in an old country like India, with a completely organised system of foreign trade which entirely deprives industrial pioneers of the protective effect of imperfect business arrangements.

India is in close touch with the markets of the world. She has a magnificent system of Railways and the cost of transport of her trade, both internal and external, is extremely low. As an agricultural country the benefits there-

by conferred on the people are enormous. But the very perfection of the system, constructed and worked by alien agencies, militates against the development of her manufacturing resources by minimising to the utmost extent possible the natural protection which imperfect means of communication afford.

The position of the Indian student in England has been the subject of much discussion of late and not a little has been done to render the period of his sojourn in that country pleasanter from a social point of view and more profitable from a practical one. For many years past, Indian students have proceeded to England to finish their education but, of late years, the number has increased to a surprising extent. It is probably a symptom of the unrest and discontent with the present state of things which more or less prevails among that section of the population which has come most closely into contact with and has been most affected by European ideas. Some go to the Universities with the object of competing in the Civil Service Examinations, some to the Hospitals to study medicine, some to read law and get enrolled as Barristers and a few chiefly of the wealthy classes, with no defined object. All these know before they start what prospect is in front of them when they return. With the technical students, it is however otherwise, and it is the difficulties of their position to which I think attention should be drawn.

The Civil Servant comes back to India to engage in the administrative work of the country, but he has to begin in a very humble capacity and gradually work his way up. The Barrister similarly, whether it be in a High Court or before District Judicial authorities, begins at the bottom of the ladder and slowly and after much hard work wins a reputation for himself which enables him to command fees which represent something more than a

living wage. Some what similary situated is the doctor, the educationalist and the merchant, but excepting the rare case where the technical student belongs to a family already engaged in manufacturing work, he is in an altogether less satisfactory position. He has been through a College course and possibly done exceedingly well. His English compeers find employment without great difficulty but seldom of a lucrative character and they are content to wait till they have acquired practical experience before they command more than a nominal remuneration for the services they render. The Indian student would probably do the same in India, if he could, but either the industries do not exist or they are under control which turns a deaf ear to his request for employment. Vainly he essays to raise capital and start on his own account. Much sympathy is extended to him, but little practical assistance, and no one is willing that he should gain his experience at their expense.

Sufficient time has not yet elapsed since the technical students first went abroad for these facts to become widely known and the bulk of those who have returned have so far been lucky enough to get work of some kind though generally not that for which they were looking. The training abroad has been an excellent education in itself, their travels and adventures have widened their outlook and made them more useful members of the community. So far India has been able to make use of such young men but the numbers are increasing, and year by year, the proportion of returned students, who are not doing well, will be found to increase. It is not unlikely that, if the movement continues to grow, the remedy will prove worse than the disease and it would be well that those, who are furnishing funds for students to go abroad to obtain technical training, should pause and take steps to

ascertain the results that have so far been achieved. The position is a very unsatisfactory one ; Government are helpless in the matter and there seems to be no simple way out of the *impasse*. English manufacturers look upon Indian technical students as possible future competitors and naturally they will extend to them none of the facilities or privileges without which experience cannot be gained. Foreign manufacturers, especially in Germany, welcome Indian students and afford them greater facilities but only because they regard them as possible future customers. The students do not fully recognise this and are apt to return to India with the idea that have been better treated on the continent than in England. The limitations of the assistance they have received are disregarded and and its one sided character only becomes apparent to them when they proceed to make use of it.

It may be safely stated that the majority of the students who proceed from India to England for technical education do not possess the necessary qualifications for the work they have taken up. Few of them have attained distinction in their previous educational career and few have any knowledge of or connection with the industry in India which they propose to take up. They are looking out for some means of making a livelihood and the problem is shelved for a year or two if they can get a scholarship to go to England. For some years I examined all the applications received in Madras for the Government of India Technical Scholarship, which is annually allotted to this Presidency, and the difficulty was not to select the candidate from among the applicants but to find one who was in the least degree likely to make good use of it. Equally my experience with returned students has been very unsatisfactory though, to be fair, I must admit that it generally as a last resource that they have appealed to

me for employment or assistance, and in consequence I have seen and heard more of those who have failed than of those who have done well.

It is not difficult to point out the direction in which remedial measures may be taken but to get them carried out is quite another matter. In the first place it would be well to institute a more searching examination into the qualifications of students before they are allowed to leave this country and the standards set up by the Provincial Government in respect to Government of India scholars might be adopted with advantage by those who administer the various funds which have been started to send students abroad. Next it should be remembered that the ultimate object in view will more likely be attained by a few good men than by a crowd of mediocrities. The idea should not be to send as many students as possible and for the shortest time and with the smallest allowances on which they will consent to go. These are matters about which the candidates for scholarships know little and it is to be feared that those who send them know less. The scholarship funds ought to be administered by people who understand what they are doing and who are capable of making arrangements suited to the requirement of each scholarship holder. It is not enough that they should be sent for a year or two years to a technical school and then left to shift for themselves. The school courses, without subsequent opportunities to gain practical experience, are worse than useless as they only tend to demoralize the individual. Unless the technical training can be completed it is better that it should not be entered upon.

A very large proportion of the trade between England and India is on this side in Indian hands and these men, who distribute the imports through the country, have a powerful lever to open the doors of English manufacturers

to admit Indian apprentices. It is doubtful if their assistance has been asked, and, if so, it is not unlikely that it has been refused, as the Indian merchants who trade in European imports, are by no means keen to see their business dwindle before an advancing wave of Swadeshism. Public spirit and whole hearted co-operation are sorely needed in Indian affairs and things will not go well till these tender plants have attained a more sturdy growth than at present.

The want of co-ordination in the various interests involved in the Swadeshi movement has been, and will continue to be, a fruitful source of waste of energy and resources. In no direction is this more evident than in the haphazard way in which the question of foreign technical education has been dealt with. In a few years time we shall have the country flooded with half-trained young men full of wild cat schemes for spending other people's money. The present procedure is "putting the cart before the horse" and till it is recognised that industries must precede technical education progress is bound to be slow. Till Indian capital flows freely into industrial ventures but little can be done. In the early stages European control is essential and what India really wants at the present moment is the establishment of an *entente cordiale* between men with money in this country and men with industrial experience from outside. Co-operation between the two should be productive of great results, but that it may take place there must be mutual respect and faith in one another on the part of both, and there must be a willingness to risk and venture capital on the part of the Indian of which at present there are few signs.

II

EXPERT ASSISTANCE

A FAIRLY intimate acquaintance with what has been going on during the last few years in connection with

industrial development in the South of India leads me to the conclusion that, whilst the average educated Indian has very little faith in Joint Stock enterprise, the Lord has given him a good conceit of himself and he is willing to risk his money fairly freely in undertakings of which he has very little practical experience, provided he is able to retain complete control of the expenditure. No doubt, in many cases, these not infrequently weird ventures are the outcome of family pressure and are designed to assist a son or nephew who has not succeeded in carrying off any of the prizes which fall to the lot of those who do well in schools and colleges. Several interesting instances have come to my notice where comparatively wealthy fathers have started their sons in some kind of practical business without first giving these sons a sufficient training to ensure a fair prospect of successful result. Too late they have learnt that their own experience, generally in the legal profession, has availed them but little in supplying the deficiencies of their incompetent relatives. For obvious reasons details of these failures cannot be given and I allude to them chiefly because, if, at the inception of these schemes, disinterested expert advice had been obtained, many of them would have been worked on different lines.

It is true there is great difficulty in getting any such expert assistance as there are no consulting engineers practising in this Presidency and the few technical experts, outside Government service, are in the employ of private firms who naturally do not allow them to take up work on their own account. The experience of the Department of Industries in connection with such matters may be worth recounting, especially in view of the fact that its operations in this direction have received the approval of the Secretary of State, and the Madras Government are doing what they can to provide a staff of experts whose services

will be available to those who want them. During the last few years applications have been made to me for assistance in a great variety of ways and not the least useful result of these applications has been that I have succeeded in inducing some would-be pioneers to drop their projects and save their money. It is chiefly in connection with the development of lift irrigation by mechanical means that, in the Department of Industries, we have been able to render positive assistance to a large number of people. At the beginning advice was gratuitously given to all who sought it, and the work of supervising the erection of installations was undertaken free of charge. Two years ago the experimental stage was considered to have been passed through and Government sanctioned the levying of fees of a very moderate character from those who sought the advice or benefited by the experience of the trained staff of mechanical assistants who had been gradually got together to deal with this branch of our work. The fees which may be levied do not cover much more than 10 per cent. of the cost of the work, but their effect has been remarkable. To avoid paying these fees ryots dispense with the advice of this department, purchase their machinery from commercial agents who have no practical knowledge of its working, and usually procure the service of second rate mechanics out of employment to erect it. The results may be described as invariably unsatisfactory and we are frequently called in as a last resort to make the best of a bad job. The extent to which this is going on may be gauged by the fact that in 1909-10, whilst 33 installations were set up by the Department, no less than 28 were started without its aid. In a few of these cases the work was done by competent engineers connected with European firms and to such instances my remarks do not apply.

For years we have been studying how to get at whatever supply of underground water there may be and have endeavoured at least to keep abreast of progress in methods of lifting water. The design and erection of some 300 pumping plants has enabled us to accumulate valuable experience, but, to save a few rupees whilst spending thousands, this is put on one side and the penny wise and pound foolish cultivator puts himself in the hands of an ignorant mechanic or a plausible salesman.

With what results the publication of a few examples may serve some useful purpose. But before doing so I must explain that, in designing pumping plants, our object all through has been to reduce to the lowest possible figure the ultimate cost of lifting water. To achieve this the engine must work on liquid fuel which is roughly half the price of kerosine oil or if a gas plant is installed, charcoal must be readily procurable at a reasonable price—usually about Rs. 20 a ton. Then the engine must be of sound construction with working parts that can be easily renewed ; it must be of simple design and reliable in action. If these conditions are not favourable the repair bill will be heavy, breakdowns frequent and a skilled attendant will be necessary to keep it running and that means that he must be paid high wages.

Turning to the pump for lifting the water, it must be of a suitable type for the work it has to do. It must possess a high efficiency and be so constructed that it will run for hours or days at a high speed without any attention worth speaking of. There are many pumps on the market suited for various conditions of work, and in many cases a very high efficiency is a matter of no great moment, but to the ryot, whose pump will be running 10 or 12 hours a day or for even longer hours, efficiency is of

considerable importance. Now, there are pumps on the market which will do 50 per cent more useful work than others with the same expenditure of engine power. Naturally these pumps are more expensive, but a smaller engine can be used to drive them and what is saved in the cost of the engine frequently more than compensates for the extra cost of the pump, so that, with the better pump the actual capital outlay is even slightly less and the working costs, in respect of fuel, permanently smaller. Between the brake horse-power of the engine and the useful work to be obtained from the pump, a certain ratio should exist, departure from which means either trouble in working or waste of capital outlay. Lastly, the varying conditions as to volume of water supply and level from which it has to be raised at different times of the year materially affect the choice of the pump and the general design of the installation. It may also be mentioned that, during the last few years, very marked improvements have been effected in the design and construction of both engines and pumps, and patents soon get out of date. The Indian ryot is a suitable victim on whom to dump the machinery unsaleable in a more intelligent market and, naturally, stock of this description is readily sold at greatly reduced rates. Till the expiry of the patents on the Hornsby-Ackroyd engine, save for the competition of the Diesel engine in larger sizes, it enjoyed an absolute monopoly of the market for engines working with liquid fuel. Numerous other types of engines did very well with kerosine oil, but, in most cases, their manufacture was given up directly the master patent of the Hornsby Engine expired. Not a few of these old fashioned engines have been sold in India and they are working in a perfectly satisfactory manner, save that they cost their unfortunate owners thrice as much for fuel as is

really necessary to generate the same amount of power. Obviously, some technical knowledge and practical experience is needed to steer clear of all these pitfalls, and that they have not yet been avoided the following cases will demonstrate :—

1. In the early days of irrigation by pumping a ryot purchased an engine and pump which would only work on kerosine oil and frequently got out of order. When asked his reason for purchasing the plant he produced a number of illustrated catalogues and stated that his choice was determined by the superior character of the illustrations and printing of the catalogue.

2. A Hornsby Oil Engine was purchased in Calcutta and its erection entrusted to a local blacksmith. The work was not satisfactorily carried out and one of my Supervisors was asked to put it right. Whilst inspecting the running of the engine the fly-wheel burst and killed the unfortunate man.

3. For one ryot on the Kollair Lake we installed a 16 B. H. P. engine and a 10" pump. For a similar scheme another man independently purchased a 24 B.H.P. engine, which would only run on kerosine oil, and an 8" pump, with the result that he pays three times as much to lift his water. An even worse case in the same neighbourhood is the employment of a 32 B. H. P. engine to drive a pump for which a 12 horse-power engine would be is sufficient.

4. An enterprising Zamindar, who ought to have known better, purchased on his own account a 24 B.H.P. engine and a 10" pump. The engine is not of a satisfactory type and is of nearly three times the power necessary to drive the pump on the lift on which it will be worked. When the mistake was pointed out to him he promptly paid the departmental fees lest, in the erection of the machinery, worse errors might be made.

5. In one case I inspected a factory which could have easily been driven by a small oil engine. To do the work I found installed a large portable steam engine of an expensive type with the wheels bedded in a mass of concrete. The capital outlay involved in this case must have been at least four times as much as was necessary and the working expenses increased in about the same proportion. I need hardly say that at the present time the factory is closed and the owners have probably lost all the capital they have invested.

6. There are a number of engines offered for sale in the Madras market which are quite unsuited to ryots' requirements, but because they are cheap they have been largely purchased and it has come to our knowledge that many of them are already worn out and in least two instances we have replaced them by new engines.

7. In a number of cases existing installations erected by this department have been copied, but the work has been entrusted to inexperienced men with very unsatisfactory results and the owners have finally had to appeal to this department to re-erect their plant in a suitable manner.

Experientia docet, and I am glad to say that at the present time there seems to be less inclination to avoid paying departmental fees and it is possible that this outburst of independence will prove a temporary phase in the development of South Indian industries. It will, I think, be our policy to increase fees till ultimately they fully cover the cost of the work done, as our main object is to develop a healthy state of industrial enterprise in which it will be possible for qualified experts to make a living. How long it will be necessary for Government to nurse this particular form of enterprise, it is impossible to say, but unquestionably it may be taken as certain that

State assistance will be withdrawn as soon as it can be safely left to private effort. In the initial stages of any new development in this country, it is essential that private enterprise should be able to command competent expert advice so that the little capital available should be invested to the best possible advantage.

I have purposely drawn my illustrations from the operations of the Pumping Department, but it would be equally possible to furnish quite as glaring examples of waste of money in other directions. Failures due to incompetence are dotted all over the country and each serves as a deterrent to other people. When, however, a certain amount of success has been achieved through careful adaptations of means to ends, over-confidence is sure to establish itself and the services of the expert are dispensed with, to save a little money or gratify the vaulting ambitions of incompetent amateurs. It is remarkable that in commercial and industrial matters the value of expert assistance should not be recognised because in legal matters it is very different. Not uncommonly the would be purchaser of an engine and pump employs the services of a *vakil* to interview me and explain the situation. It is quite unnecessary; but such is the force of habit that he thinks he will be better served thereby. If a similar frame of mind could be developed in respect to expert technical assistance, industrial progress would undoubtedly be more rapid. The consulting engineer and the technical expert cannot obtain enough practice at present in this Presidency to make it worth their while to start in business and there is no doubt that the absence of these specialists seriously handicaps private effort. The Bureau of Industrial Information to the establishment of which Lord Morley has accorded his sanction will, to some extent, supply the

deficiency and it might be further met by allowing the technical experts of Government in the Education Department to engage in a limited amount of private practice. There is a precedent for this in the case of the Medical Department, and in the Indian Institute of Science it has been expressly stipulated that the professors of the staff should, within certain limits, be allowed to engage in work on their own account. It is perfectly easy to frame rules to prevent any undue development of private work to the neglect of public duties, but the main argument in favour of this policy is that its adoption must necessarily render the work of the teacher more practical. A Medical College staffed by officers, who never went inside a hospital or visited private patients, would be considered a strange anomaly, but Engineering Colleges and Technical Schools are usually in this position. In some cases, their officers have no practical experience of engineering work in this country and, however able they may be, it necessarily follows that their teaching must lack that living interest which only profound practical experience can impart.

CHAPTER VII

CHROME TANNING.*

I

One of the objects of your Association, which has only recently been formed, is the discussion of economic questions and the promotion of industrial activity. As an association it is, of course, only possible for you to take an indirect part in the development of commercial enterprise ; but in view of the conditions which prevail in this Presidency, I think that, if your efforts are made on proper lines, you may be able to do a very large amount of valuable work.

For many years past the indigenous industries of this country have been going from bad to worse and nothing has been done to arrest their decadence. At the same time a new India has been growing up, characterised by great industrial activity, but in its creation you have only borne a very subordinate part. Great industries are springing up in India and large amounts of capital are profitably invested in them, but your share is insignificant. The cotton spinning industry of Bombay is mainly in the hands of Parsis. The jute trade of Bengal, the leather trades of Cawnpore, and the great planting industries of Assam and Southern India are entirely financed and controlled by Englishmen. I am not going to trouble you with figures

* An address to the South Indian Association, 1905

showing the vast amount of capital which has been sunk in India in the magnificent system of railways and in the perhaps still more wonderful irrigation works, but you all know it is very large and that the bulk of it has come from Europe. India is growing richer day by day, and I think, no unbiased mind can reject the evidence that throughout the length and the breadth of the land the people are on the whole, more prosperous and well-to-do than they were. But their progress is slow, so very slow that compared with Western nations the increase in material prosperity seems to be almost negligible. The reason for this is entirely due to your own peculiar mental attitude, which in being unable to shake off the customs and habits engendered by the necessities of other times, displays a singular want of elasticity. When life and property were very insecure there was a great deal of common-sense in investing one's wealth in readily portable forms; but the habit of hoarding which was then advisable is now simply utter foolishness. It has been computed by authorities, who are supposed to know, that no less than 550 millions sterling or over 800 crores of rupees are at present lying idle in this country. Whether these figures are strictly accurate or not, matters little. We all know that the total amount is a very large one and some of us are equally certain that, if we could induce you to bring forth your hoards and put them into circulation, the result for India would be very striking. Those of you who are mathematicians will understand me when I say that whilst the Western countries are accumulating wealth with a full knowledge of the laws of compound interest, you are not even investing your hard earned savings so as to obtain simple interest upon them. Everywhere we hear the cry that it is only capital that is wanted to develop India and everywhere we see the people of the country

burying their capital in the ground or hoarding it in strong boxes.

Now I take it that one of the most important functions of your association is to spread abroad new ideas on this subject and do all you can to combat your national weakness. The vast industrial and commercial transactions of modern times are based upon a gigantic system of credit and, where credit is most easily obtainable there progress is greatest. In India credit is at a very low ebb and there is no movement at the present day calculated to confer greater advantages on the people of India than that in favour of the establishment of Agricultural Banks, which if they are successful, will add enormously to the credit of the cultivating classes and in an equal degree diminish the tyranny of the money-lender. When money can be readily obtained at reasonable rates of interest the trade of the sowcar will disappear and the money, which now accumulates in his hands, will have to find other spheres of employment and you will, probably, be content to invest it in some industrial enterprise yielding you a steady return of from 5 to 10 per cent. Some of you invest money in land and consider yourselves lucky if it yields 3 or 4 per cent. The ownership of land, which other people want, confers a sense of power and flatters one's vanity and these pleasing sensations are part of the return which you get on your investments. If you could only be induced to look at industrial enterprise in the same light, it would be an important step in the right direction. It would be well if you could be induced to invest money in industrial undertakings and if, to the direct return in the shape of dividends, you could add a sense of satisfaction at the thought of your enterprise and how much it means those to whom it gives employment, things would be greatly better than they are.

I am induced to make these remarks, because my work is almost entirely confined to the improvement of the indigenous industries of the country and in no matter what direction I turn, I find that to put things on a better footing, capital is required, and if you are to benefit by the improvements, you must supply the capital. Hitherto my experience has not been encouraging. Nearly seven years ago we started, in the School of Arts, to work in aluminium instead of brass and copper with the object of introducing a new metal to the metal workers of this country to enable them to preserve that part of their business which was threatened with extinction by the competition of imported aluminium wares. From the outset we were very successful and made not a few efforts to induce native capitalists to take up what seemed likely to prove a very profitable business, but there was absolutely no response and eventually it was a certain number of enterprising Englishmen who thought it would pay them to take up and carry on the industry which had been pioneered through its infant stages by Government. I think I am not very far wrong in saying that the shares of the Indian Aluminium Company are mainly held by Europeans and that the profits of this industry go into their pockets. Of course, employment is found for a considerable number of artizans and the industry benefits the country generally, in exactly the same way as do those bigger industries to which I have already referred. But a good opportunity has been lost to found a native joint-stock enterprise as the success of the Company in native hands would have been a most encouraging and valuable object-lesson.

During the last 60 years a most important export trade has been built up in hides and skin amounting in value at the present time to an average of about 10 crores of rupees

a year. Madras and Calcutta are the two great centres of this export trade ; but whilst the exports from Calcutta almost entirely consist of raw hides and skins, those sent out from Madras, till quite recently were invariably partly manufactured leather. Of late years Bombay has claimed a not unimportant share in the trade and with its great natural advantages as a port of shipment it is likely that the trade there will grow, partially by natural development and partly at the expense of other exporting centres. The annual value of the exports from Madras varies between $2\frac{1}{2}$ and 3 crores of rupees. During the last 10 or 15 years the volume of business passing through Madras has not materially increased in amount, owing probably to the fact that the limit of production of the Presidency has been reached, but the value of the business transacted has increased by fully one-third owing to the rise in prices in the markets of Europe and America. It is not my purpose this evening to enter into any detailed account of the tanning industry in this Presidency. Those of you who wish for information on this point will find all that I have been able to gather in a Monograph on Tanning and working in leather in the Madras Presidency, which has recently been published by the Madras Government. What I want to do is to draw your attention to the remarkable change which has come over the leather trade throughout the world owing to the introduction of a new system of tanning, which produces a leather in some respects so very much superior to that we have always been accustomed to. In this new process certain salts of chromium take the place of tannin and the resulting material possesses some very remarkable properties. The production of vegetable leather is a long and tedious operations which, when carried out in the most perfect manner possible, as in the case of thick

hides from which, what is known as sole leather, is produced, requires from a year to 18 months. Chrome tanning is a very much more rapid process and even the thickest hides seldom require more than a week for their complete conversion into leather. The leather exported from India has hitherto been sent away in an unfinished condition and the dressing of the skins or the currying of the hides is completed in the importing countries. Now with chrome leather it has been found necessary to proceed with the finishing processes immediately after the material is taken from the tanning bath. The reason for this is that chrome leather when once dried can never be properly wetted again.

In the United States of America there has always been a very considerable demand for Madras tanned goat skins but the growing popularity of the chrome tanning in that country and in Europe has led to the abandonment of Madras tanned goat skins in favour of raw or pickled skins. To the tanning trade of this Presidency the result has been somewhat in the nature of a disaster, as a very large percentage of the skins, which formerly passed through the Madras tanneries, now leave the country without any treatment except that necessary to preserve them in good condition.

Two years ago I was asked by the Madras Government to enquire into the state of the tanning trade in this Presidency and to ascertain whether the intervention of Government in any way would be of advantage to the trade. My report was naturally based upon the information which was kindly furnished to me by those interested in the trade in Madras; and it was to the effect that whilst the peculiar properties of chrome tanned leather require that the finishing and dressing processes should follow in unbroken continuity on those of the tanning, the

fiscal regulations of foreign Governments rendered it impossible to export to them finished leather or dressed skins. In the course of my enquiries I found that some attempts had been made to produce chrome leather in this country, but solely with the view of exporting it abroad. They had ended in failure and the failure was attributed to the unsuitability of the Indian climate for chrome tanning and to the non-existence of skilled labour such as is necessary for the dressing and finishing of leather of the high quality required in Western markets. From the outset I doubted very much if there was anything whatever in the climatic difficulty and I may say at once that subsequent enquiries both in England and in America, clearly showed that the hot climate of Southern India was in no way a barrier to the production of first class chrome tanned leather. Later on enquiries which I had to make to obtain information for the preparation of the Madras Monograph, to which I have already referred, revealed the fact that there was in India itself an enormously large consumption of leather and that the great bulk of that leather was of an exceedingly poor character. It was, therefore, obvious that though there might be no external market for Indian chrome tanned leather there was undoubtedly a very big market at our very doors.

Before proceeding further I think I shall make the position clearer by quoting from an American book on the manufacture of leather written by Mr. C. T. Davis, who describes the characteristics of chrome leather in the following terms :—

“ Chrome leather has special and peculiar qualities which distinguish it from all other kinds of leather and these features cause it to be a superior fabric for all the purposes for which leather is used. It has often been stated that chrome leather is water proof, but this is not a

proper term to use in connection with it, it should more properly be called non-absorbent. All kinds of leather produced with tannin absorb water readily, like a sponge, while chrome leather does not absorb water but resists it or sheds it, like the feathers of a duck. In fact it is a difficult matter to thoroughly wet chrome leather when it is once dry. Again, water and air are the agencies in nature which promote decomposition and decay, and as tanning and hide substances are both organic materials, and when combined as is the case in bark tanned leather, and subjected to the process of wetting and drying, such leather will eventually but surely deteriorate and become rotten. Chrome leather, on the other hand, being a combination of an inorganic material with the hide substance and subjected to the same process of wetting and drying, shows no effect whatever. In fact the oftener chrome leather is wet and dried the softer and more flexible it becomes. Even subjecting it to boiling water apparently has no effect upon it, while any sort of leather produced with tannin and placed in boiling water is utterly destroyed. Moreover chrome leather is of much lighter weight than bark leather and this is decided advantage for almost all purposes for which leather is used."

Compared with European countries the consumption of leather per head of the population is comparatively small, but in the aggregate, nearly three hundred million people being concerned, it is enormously large, and it is probable that the value of the leather used in India exceeds the value of the exports of hides and skins both in the raw and manufactured states. No statistics are available on the subject and only the roughest possible guesses can be made. From the Census returns of 1901 it appears that the total number of people in the Madras Presidency

who are partially or entirely dependent upon the leather trades is 190,000 and of this number nearly 112,000 are engaged in the manufacture of boots and shoes and sandals and 51,000 in the manufacture of water buckets, wellbags, buckets and ghee pots. The amount of work put into a given quantity of leather by the chuckler who makes foot gear is very much larger than in the case of the water bucket maker ; and it would not be unfair to assume that the consumption of leather in these two branches of the trade is approximately equal. Of irrigation wells there are in this Presidency more than 600,000 and though the piccotah is largely used for the lifting of water from shallow wells, from the majority the water is baled by means of mhote. Iron buckets are almost invariably used with piccotahs but with the mhote the leather kavalai is practically universal. The buckets hold from 10 to 50 gallons of water and are generally made from fairly well tanned cow hides, though for very large buckets buffalo hides are sometimes used. The bucket is roughly semi-cylindrical in shape and suspended from an iron ring. At the bottom is a hole about 9 inches in diameter which leads to the discharge pipe, a leather tube 4 to 6 feet long, the open end of which is attached to a rope. With the method of working you are all completely familiar and to what I would draw your attention is the very hard treatment which the leather receives in the hands of the ryot ; alternately wet and dry and seldom or never greased the leather perishes rapidly and, where the bucket is used every day, its life is seldom more than six months and during the latter part of that time it requires frequent repair, which is a source of much annoyance to the ryot as he is entirely in the hands of the chuckler. It would, probably, be a fair assumption to make that the life of a kavalai does not average more

than a year; and that throughout the Presidency fully one million hides per annum are used for these purposes. The value of a tanned hide is from 3 to 4 rupees and the kavalai complete will cost the ryot from 6 to 9 rupees. The expenditure, therefore, on water buckets, including repairs, can hardly be less than 40 lakhs of rupees per annum.

From Mr. Davis's description of the properties of chrome leather I think you will agree with me that chrome tanned leather is an eminently suitable material for the manufacture of these buckets. During the last 12 months we have manufactured and sold a considerable number of them and from enquiries which have been recently made I learn that the majority of the purchasers are well pleased with them, but I must also admit that in some instances the results have not been satisfactory. I mention this, because I wish you to be in full possession of the facts, and because it gives me an opportunity of explaining the unsatisfactory results which have in some instances been obtained. When we first commenced operations we had no practical knowledge of chrome tanning and our earliest attempts at the manufacture of chrome leather were accompanied by a considerable number of failures. In some cases the leather produced was apparently perfectly good but unfortunately we neglected to neutralise the acid which was left in it, and it is the presence of this acid which, at the time escaped notice, which has been the cause of some of the failures which I have brought to your notice. Now that we are aware of the importance of completely neutralising any acid that may be left in the leather after tanning we take good care that this is done. The leather water-buckets, now made, are completely free from this defect and I have not the slightest doubt they will prove considerably

more durable than the country tanned water-buckets which we hope to supplant. It would perhaps be rash to make any estimate as to how much longer life a chrome tanned bucket is likely to have, since sufficient time has not yet elapsed for any bucket of well made chrome leather to wear out. But from a variety of data which I have in my possession I think we may safely count on one chrome leather bucket outlasting at least two of the ordinary tanned kavalais. Supposing then that chrome tanned leather were universally employed for kavalais, one-half the number of hides now used would suffice for the present requirements of the ryots. If our estimate that one million hides per annum are used for kavalais is correct, the use of chrome-tanned leather would mean a saving of 5,00,000 hides, which if we value in their raw state at only Rs. 3 each, will mean an annual saving of at least 15 lakhs of rupees. These hides will be available for tanning for the export trade and when sent down to Madras would swell the volume of the exports from this Presidency by probably more than twenty lakhs of rupees.

The technical details of the chrome tanning processes it is not necessary to describe but it is important that I should give you some idea of the difference between the old and the new methods of tanning, in order that you may form some notion of the relative costs of production of chrome-tanned and vegetable-tanned leather. In the first place the cost of the raw material, namely the hides or skins, will be the same whatever process is employed. Secondly, the preparation of the pelt for tanning is in both cases the same ; only with chrome tanned leather it is necessary to be more careful about the complete elimination of the lime when the preliminary processes are complete.

In the experiments now being carried on at the School of Arts, all this work is done for us by native tanners outside the Municipal limits, and the pelts, ready for tanning, are pickled in a solution of alum and salt, which prevents decomposition and enables us to deal with them at our leisure.

The tanning solution is made by dissolving chrome alum in water and adding to it washing soda in certain definite proportions. This causes the rapid evolution of carbonic acid gas and it is necessary to constantly stir the mixture. To this solution common salt is added, in order to swell the pelt and enable the tanning liquors to operate rapidly. The tanning process may either be carried on in vats in which the pelts are suspended, or, as is the practice in the School of Arts, in rotating drums, which enable us to keep the pelts in constant motion in the tanning liquor.

Sheep skins are usually tanned in 3 or 4 hours, goat skins in 5 or 6 hours, raw cow hides in 24 hours, and very heavy buffalo hides in 7 days. When the goods are completely tanned they are of a uniform blue colour throughout the section and, after this is attained, it is advisable to allow them to remain in the bath some little time longer. They are then removed from the tanning drums and piled on a table for about 24 hours, to allow the tanning liquors to thoroughly complete the tanning process. After this the pelts, which are now converted into leather, are well washed in several changes of water and are then put into a solution of borax and water to neutralise any traces of acid which may remain. This last step is of extreme importance if the leather is to be of a durable character and careful tests have to be made to determine that no traces of acid are left. Further washing with water completes the tanning

process and the leather is now ready to be dyed or fat-liquored according as it is required for conversion into finished leather, such as is used for boots and shoes, harness and saddlery, or book binding and upholstery work, or for such rougher work as the manufacture of piccotah buckets, kavalais, leather ropes and the commoner forms of boots, shoes and sandals. The dyeing of chrome leather require great care and experience to produce uniformly good results.

The fat-liquoring by which we introduce a certain amount of oil into the structure of the leather is a very simple but a very important operation. Castor oil is made into a soap by the addition of caustic soda and to this a certain proportion of castor oil is added and the mixture dissolved in hot water. This forms a complete emulsion which the leather readily takes up. The leather is placed in a drum with the fat liquor and in 20 minutes or half an hour all the oleaginous matter passes from the water into the leather. After fat liquoring the leather is kept in a moist condition all night and next morning it is sleeked on a stone table and then stretched out on boards to dry. When this is complete the leather is rather hard and requires thoroughly staking, whereby it is rendered very soft and pliable.

From this brief account of the process of chrome tanning you will see that there is nothing about it that is expensive and the cost of producing chrome leather should only be very slightly more than that of ordinary bark-tanned leathers, the difference being due to the slightly greater price which has to be paid for the chemicals as compared with the tanning bark.

I have now placed before you the salient facts relating to the manufacture of chrome leather and it only remains for me to point out what I consider to be the best

way for you to deal with this industry if you wish to take active measures to foster it throughout the country. In the first place, it is necessary to disseminate a knowledge of the properties of chrome leather among the cultivating classes throughout the length and breadth of the country. Unfortunately, the ryots do not, as a rule, read newspapers, and ordinary advertisements are therefore of little use. Many of you own lands yourselves and have possibly numerous kavalais in use. For these you can yourselves try the chrome leather and you can all of you bring it to the notice of your friends and get them to try it. In this way there will be created a very considerable demand, which should rapidly grow far beyond the capacity of the present plant of the School of Arts. I would suggest to the Committee of your Association that you should appoint a Sub-Committee of three of your members to investigate the facts which I have placed before you. The Sub-Committee having come to a definite conclusion might submit a report to your General Committee, and if that report is, as I think, I may fairly anticipate it will be, a favourable one, it remains for you to consider whether it will be worth while to start a limited liability company with sufficient capital to carry on the process in several parts of the Presidency. With a lakh of rupees, which you might raise by issuing 4,000 shares at 25 rupees each, it would be quite easy for you to establish at least 4 tanneries in the centres of the great well cultivation districts such as Bangalore, Vellore, Dindigul, Coimbatore, Bellary, and Trichinopoly. Local hides could, at any of these places, be purchased cheaply and I am sure there would from the outset be a rapid and growing demand for kavalais and it would also be possible to arrange to tan hides belonging to the ryots themselves.

The work in and round Madras and for other parts of India might still be continued by the authorities in the School of Arts, and I think, it is not improbable that Government will be prepared to develop the experimental tannery now at work and make it a real centre of instruction for the tanning trade of this country. Into the details of what we might do at present this is hardly a convenient time to enter but I think if you will actively co-operate in the work we have done, there is a fine field of usefulness for a tanning school in Madras.

The imports of manufactured leather, notwithstanding of the great tanneries at Cawnpore, still amount to a very considerable sum and by the proper application of energy and skill it should be possible to capture a very large proportion of this trade in finished leather goods. The initial work of training the labour may well be undertaken by a Government Institution and, I think, that it is highly probable that Government would be prepared to find the funds necessary, if they were assured that there is an energetic and capable native public ready to take up and turn to advantage the work of the school.

II

HIDES and skins, either in their raw condition or lightly tanned, form important items in the export trade of India. Fluctuating from year to year and dependent to some extent upon the character of the season, they have for some years past averaged about 9 crores of rupees in value, but last year * stimulated by the high prices obtainable in Europe and America the value of the trade rose to nearly 14 crores of rupees and in the list of exports arranged in the order of their importance they have now reached the fourth place. The great bulk of the trade is

* 1906.

done in the raw material and is mainly from the three Presidency ports of Calcutta, Bombay and Madras. The Calcutta trade is entirely in raw hides and skins, the Bombay trade includes a considerable percentage of tanned hides and skins, whilst in Madras only tanned hides are exported and in the skin trade nearly two-thirds of the value of the exports are in the tanned condition. Up to the year 1898 there was no export of raw material from Madras, and although now in the skin trade it amounts to nearly 40 per cent. it has not grown so rapidly as was anticipated some four or five years ago.

The demand for leather throughout the world seems to be rapidly increasing and, being in excess of the supply, prices have had an upward tendency for many years past. Excluding the great stock raising countries, such as the Australian Commonwealth and the Argentine Republic, India is one of the few countries which on account of its poverty is still able to export a very large proportion of the hides and skins which it produces. The external trade has risen to nearly 14 crores of rupees, but it is impossible to even roughly estimate the value of the internal consumption. Possibly its value is as great or greater than that of the external trade and there is evidence that it is steadily rising. Indian skins are of good quality, but with few exceptions the hides are inferior and it is impossible to obtain a first-class manufactured product from them. Cawnpore is the centre of the modern leather trade and Bombay, on a smaller scale, produces leather in no way inferior. This industry has grown up under the stimulus of demands from the Military Department and its flourishing condition to-day is due not only to the expansion of military requirements but also to indents from other Government departments which in the aggregate require considerable supplies of leather goods. In recent years

an internal demand has grown up for cheap machine-made boots and shoes and it is probable that the Swadeshi movement, especially in Bengal, has benefitted local manufacturers of such goods. Excluding boots and shoes, the value of which is not given separately, the trade returns show that from 25 to 30 lakhs of rupees worth of leather or leather goods are imported into India yearly. The bulk of this trade is probably in dressed skins for book-binding and upholstery work, in high class leather for belting and machinery and to some extent in fancy leather goods. It is hardly probable that the whole of this not inconsiderable import business could be captured by native manufacturers, but there is no reason, except want of enterprise on the part of the manufacturers, why India should not produce dressed skins equal in quality to any made in Europe and America.

The bulk of the leather used in the country is very poor stuff and the methods of tanning are so crude that vast quantities of fairly good hides are converted into most inferior leather. The inefficiency of the indigenous tannery is notorious and in the aggregate the annual waste of material amounts to a sum which can only be estimated in crores of rupees. Boots and shoes, sandals, harness, mussels, paccali bags and bags for lifting water from wells for irrigation are among the chief articles for which the inferior country leather is in large demand. No information is available regarding this native business. The village chuckler was both tanner and leather worker, but in the South of India at any rate, the numerous tanneries which have sprung up for dealing with the surplus hides and skins available for the export trade, have also secured a good deal of his business as a tanner. Yet he is by no means extinct and the enormous increase in the export trade of the last two years

indicates the probability that there is still a good deal of valuable material to be rescued from his primitive methods of treatment. In one direction due to the increase in the number of wells used for irrigation from which the water is drawn by mhotes there has certainly been an enormous expansion in the local demand for leather. All over India the mhote or charsa is a familiar object and every year millions of good hides are converted into bad leather for these water lifting appliances. The material is not altogether suited for the work and in constant use water bags have but a comparatively short life. If anything could be done to improve the quality of the leather and render it more durable it would be conferring a very substantial boon upon the ryot and, in proportion to the improvement, there would be set free a corresponding number of hides for export. The increasing demand for leather in India is due to a rise in the standard of living of the people and sooner or later it will affect the export trade unless, in the meantime, the available supplies of raw material are treated with greater respect and converted into better and more durable leather than at present.

The mhote in good working order, and with a water bag the capacity of which is properly proportioned to the weight of the bullocks, is an extremely efficient method of lifting water when only animal power can be employed, but the normal condition of the ryot's mhote is far from satisfactory as the bag soon becomes brittle and tears and the rents are badly patched and fully a third of the water which is lifted from the well falls back into it before the bag is emptied. In the matter of repairs the ryot is entirely in the hands of the village chuckler and if he could be supplied with a better material than the common country leather, there is but little doubt that as soon as he becomes

practically acquainted with its advantages, he will readily adopt it, even though it costs considerably more. In the South of India the piccotah with an iron bucket is almost universally employed in the Coast Districts where the water-bearing sands are not more than 12 or 15 feet from the surface and not a few mhotes, in use in brick wells are of composite construction, sheet iron being used for the bag and leather only for the trunk. With care such mhotes are satisfactory, but they are easily damaged and difficult to repair. In many districts, the irrigation wells are large holes sunk into the rock and in practice it has been found that the leather bag is superior to the iron bucket, as the latter is easily damaged against the rocky sides. Moreover, they must be very thin or else the weight becomes excessive and when very thin they require carefully looking after or they rapidly rust through. From time to time experiments have been made with various substitutes for leather, but nothing seems to have caught on and it remains therefore to improve the quality of the leather till a more satisfactory substitute for it can be found.

With these facts very forcibly impressed upon me whilst conducting a series of experiments on various types of water-lift in Southern India it was only natural, when I learnt of chrome leather and the very slight action which water has upon it, to experiment with it and ascertain whether it was feasible or not to manufacture the leather in the country. The practical tanners of Madras, whom I consulted in the matter, were unanimously of opinion that, owing to the climate, chrome tanning would be a failure. They had made experiments themselves and their experiments led to nothing because their object in view was to produce a material suitable for export. That was not the way I looked at the matter at all and it seemed to me that though it might be impracticable

to manufacture chrome leather or glacé kid which would find a market in Europe or America, yet it might be possible to produce in India chrome leather suited to Indian requirements. Accordingly the Government of Madras were addressed on the subject and a sum of Rs. 2,000 was placed at my disposal for experiments on the lines which I indicated, the main object being to produce a chrome tanned leather suitable for use in well irrigation. I had no previous knowledge of leather manufacture and naturally began working on a small scale, tried many experiments and met with not a few failures, but ultimately was able to demonstrate the practicability of the orginal idea. That was probably the easiest part of the work as much assistance was obtained from such books as Procter's "Principles of Leather Manufacture" and in working out the local Indian problem the Secretary of State for India permitted me to enlist the services of a first-class English expert. The first stage has been accomplished and the more difficult matter of persuading the people of this country to give Indian chrome leather a fair trial is now engaging attention.

We can manufacture chrome leather good enough for most purposes and the experience of the last two years has shown that the original anticipations of its superiority have been fully justified. The price list of our manufactures, which we have issued recently, contains a large number of favourable testimonials from people who have used it, but still the demand for chrome leather is small when compared with the enormous consumption of leather and only very slowly do sales increase. Nevertheless we are making progress and have now some sort of assurance that ultimately the chrome processes of manufacture will supersede the crude and wasteful me-

thods of the chuckler. Many hundreds of water buckets have been manufactured and brought into use in all parts of India and the general concensus of opinion of those who have used them is that the material is superior to ordinary country leather and the life of a bucket is very much longer. As will be seen later on there is no great difference in the cost of manufacturing leather by the two processes, though naturally in an experimental tannery like that attached to the School of Arts in Madras the cost of making chrome leather is heavier than it would be in a large tannery doing a big trade. If bark tanned leather were made under similar conditions, the cost of doing so will be much greater than it is in an ordinary native tannery.

Having produced chrome leather suitable for water bags, or kavalais as they are locally known, it was natural to experiment with the leather in other directions and boots and shoes, sandals, harness and a great variety of miscellaneous articles have been made from it. The natural colour of the leather is a pale lavender blue which is almost white when the leather is made in weak solutions. The colour is not at all displeasing and a good deal of it is worked up in the undyed condition, especially for harness in Madras. Usually however, after the leather is tanned, it has to be dyed and black leather and several shades of brown leather are regularly manufactured. Experiments also have been made in tanning skins and preparing glacé kid and though it must be confessed that our productions are not equal in finish to those imported, they have proved serviceable enough and being much cheaper have found a ready sale. So far our work has been done almost entirely without the aid of machinery and now it is under contemplation to establish a separate tannery in the neighbourhood of Madras and to undertake

the manufacture of leather on a much larger scale. The plans for the new tannery have been prepared and include the installation of a fairly complete set of modern leather-dressing machinery. It will then be possible to do much better work and ultimately we hope to be able to materially displace the leather imported from Europe and America.

Characteristics of Chrome Leather.—I do not propose to discuss these at any length, but it may be well to briefly draw attention to some of the more important points in which it differs from ordinary leather. In the first place, from a given weight of hide substance, the weight of chrome leather produced is considerably less than when it is converted into bark tanned leather. In the chrome process the hide substance is acted upon by the chemicals in the tanning bath, but very little additional weight is gained by absorption, whereas, as is well known, a very marked increase in weight is obtained when the ordinary bark tanning processes are properly conducted. From ten pounds of flint dry hide the average weight of bark tanned leather produced is nearly 10 lbs., but the weight of chrome leather will be not more than $7\frac{1}{2}$ lbs. The ratio is roughly three-fourths. It therefore follows that buying chrome leather by the pound the price will always be at least 33 per cent. more than that of bark tanned leather. Chrome tanned leather is stronger than bark tanned leather, so much so that the loss in weight and decrease in sectional area is actually accompanied by an increase in the strength. Its chief physical characteristic is its extreme softness, which renders it very suitable for boot and shoe uppers. In many cases, however, stiffness is distinctly desirable, and such articles as solid leather bags and trunks are much better made of ordinary leather. Chrome tanned

leather unless very carefully manufactured tends to stretch considerably more than bark tanned leather, and for certain purposes that is considered a serious disadvantage. With care it is, however, possible to manufacture chrome leather which possesses no more stretch than ordinary leather and which, at the same time, has a considerably greater tensile strength. Harness made from the leather turned out in Madras has proved perfectly satisfactory, and large quantities of belting are in use where centrifugal pumps driven by oil-engines are lifting water for irrigation. This is very trying work for belting, and though we have not yet succeeded in producing an absolutely satisfactory chrome leather belt, yet those made in Madras are able to hold their own against the belts formerly used.

In the manufacture of sole leather the chrome process yields a material which is extremely durable, and it has been employed in making up thousands of pair of boots and sandals. The leather is sufficiently soft to make it comfortable to the feet, and it possesses a power of resisting abrasion which has never been approached by the very best English sole leather. For boots and shoes it possesses one serious disadvantage due to the fact that, when wet, the surface becomes slippery and it is not altogether safe to walk about on chrome tanned soles in cities which are paved with asphalt or stone flags. This is a matter of no importance in India where pavements are almost non-existent, and the general suitability of chrome leather for both soles and uppers is attested by the popularity of Madras chrome leather boots among the planters of India.

The final property of chrome leather to which I wish to draw attention is its peculiar behaviour when wetted. Ordinary leather when wetted and dried becomes hard

and stiff, and if soaked in water for any length of time, the water becomes turbid due to the solution of some of the constituents of the leather. On the other hand, chrome leather when wetted and dried remains quite soft, and prolonged immersion in water has no effect upon it. If ordinary leather be boiled, in a few minutes it is practically destroyed, whereas very little harm is done in the same time to chrome leather. Chrome leather is in no sense waterproof, but for practical purposes it is unaffected by water and is consequently well suited for exposure to the action of moisture.

Methods of chrome tanning employed in Madras.—In 1903, under the orders of the Government of India, a Monograph on Tanning and Working in Leather was specially prepared in each Province of India and those who are desirous of information regarding native methods of tanning will do well to consult these papers.

In an addendum to the Madras Monograph a brief account of the earlier experiments in chrome tanning is given and in the remainder of this paper I propose to amplify that note and describe in some detail the actual methods of working employed in the Chrome Leather Department.

Hides and skins.—The purchase of suitable raw material has proved to be one of the greatest difficulties we have had to contend with, as not only at the outset were we inexperienced in regard to the methods of the trade, but we had little or no knowledge as to what was best suited for the chrome tanning process. There are a considerable number of tanneries in the neighbourhood of Madras, but they mainly deal with coast hides or Calcutta rejections and it is practically impossible to get suitable raw material from such stock. We soon found that satis-

factory chrome leather could only be produced from good hides and latterly for light hides we rely almost entirely upon those which can be obtained from the Madras slaughter-houses. For a heavier class of hide, the best of which are good enough for harness leather, we mainly rely upon Nellore cow hides, of which hitherto we have been able to get as many as we wanted at very reasonable prices. For water bags, or kavalais as they are locally called, light cow hides were found to be unsatisfactory and expensive and, light buffs which are usually free from brands and are fairly cheap, have proved to be more suitable. There is a very considerable demand for chrome tanned sole leather which has to be made from hides much heavier than those usually obtainable in the local market and there is some difficulty in getting a sufficient quantity. Buffalo hides are invariably used and in the wet salted condition they may weigh from 50 to 100 lbs, depending upon the extent of the spread. One fairly large consignment of hides from Rangoon proved extremely satisfactory in regard to price, but in the absence of machinery for splitting the hides we found many of them too thick and they could only be worked up by incurring a heavy loss in shaving the leather down to a suitable thickness. Latterly we have purchased dry salted and arsenically cured hides in the Calcutta market and have found them fairly satisfactory. The demand for sole leather enables us now to make fairly large purchases at a time and there is in consequence less difficulty. It is almost impossible to procure, good calf skins but there has been no difficulty in the matter of goat and sheep skins.

It may here be convenient to mention that a very considerable business has developed in tanning skins of wild animals such as those of the tiger, panther,

bear and various kinds of deer with the hair on, and the results are extremely satisfactory if the skins are in good condition. The hair is unaffected by the chrome liquor and the skins when finished possess all the qualities of a good chrome leather. In a similar way a good many crocodile hides and a large number of snake skins, have been tanned, the latter being in great demand for the manufacture of fancy articles especially ladies' waist belts. In their natural colour they look very well and can be readily dyed to any required shade. Snake skins are very plentiful in India but so far as I know this is the first attempt that has ever been made to turn them to practical account. To obtain good results, the skins must not be damaged and special care has to be taken in killing the snakes.

Processes preliminary to tanning.—These differ very little from those ordinarily practised in native tanneries but if good results are to be obtained, it is necessary to exercise the greatest possible care at each stage. The first step is to get the hides back into their natural condition and free from blood and dirt. The dried hides require soaking in water for about 24 hours and when quite soft should be washed in several changes of water. The green and wet salted hides merely require to be thoroughly washed, and they are then in a fit condition to be put in the lime pits. These are worked in a series of four, the first pit containing the oldest lime and the last pit containing the fresh lime. The hides pass through the series of pits remaining in each pit about $2\frac{1}{2}$ days, so that the whole liming process lasts about 10 days. The operations of unhairing, fleshing and scudding need not be described here in detail as there is nothing novel about them. It is most important that whilst the hides should be well plumped up or swollen by the action of

the lime, this should not be continued long enough to allow of the lime dissolving any appreciable quantity of the hide substance. If this is not carefully attended to the final leather will certainly be unsatisfactory. In the manufacture of good sole leather this is of the greatest possible importance, and latterly we have greatly shortened the liming process by the use of sulphide of sodium.

After unhairing the hides are washed in water and put into a tub of fresh lime where in 24 hours they are sufficiently plumped to be ready for further treatment. After scudding it is necessary to remove all traces of lime from the hides, and to this end, they are thoroughly washed in water and well trodden over by the coolies. The last traces of lime are removed by means of lactic acid of which a solution containing three-quarters of one per cent, is employed. After being put in the solution, the hides rapidly lose their plumpness and become very slippery to touch. To test whether the last traces of lime are removed or not, a small piece is cut out of the thickest portion of the hide and to the cut surface a drop of a solution of phenol phthalein in alcohol is applied. If the cut surface turns red, it indicates that there is still some lime left, on the other hand if no colouration is produced it may be taken that the hide has been sufficiently delimed. Every hide is tested in this way and as soon as it passes the test is removed from the lactic acid bath and well washed in clean water.

Pickling.—The next operation through which the hides must pass is that of pickling which gives a preliminary alum tannage to the surface of the hides and thus prevents to a large extent the formation of a drawn grain when the hides are finally tanned. For the pickling solution 6 lbs. of potash alum and 4 lbs. of common salt per 100 lbs. of the drained weight of the delimed hides are dissolved in

sufficient water contained in a large rotary drum. The hides are put into this solution and kept in it for about 24 hours, the drum being rotated from time to time by hand.

Although chrome tanning can be carried on in pits or tubs, it is more convenient to employ large drums to hold the tanning solution. They are made locally of teak-wood and are mounted on a suitable wooden framing. The weight of the drum is carried by two centrally placed gun metal rings, one on each side, which rest on friction rollers supported by iron pedestals attached to the framing. On one side of the drum is fixed a large cast iron spur wheel of the same diameter as the drum and it is driven by a small pinion mounted on the framing. The drums we have constructed in Madras range from 6 to 8 feet in diameter and from 3 to 4 feet 6 inches in width. At present they are turned by hand, coolies being employed for the purpose, but it is ultimately intended to drive them all from a line of shafting. By hand power it is not possible to revolve them more than two or three times a minute, but when driven by a belt from shafting, the gearing will be arranged so that the drums make about 8 revolutions a minute. Inside the drums strong wooden pegs are fixed so as to turn the hides over as the drums rotate. This greatly quickens process of tanning and the drums can also be usefully employed for washing, pickling and for removing the last tracts of acid after the tanning processes are complete.

Chrome tanning.—There are two methods of chrome tanning known respectively as the single and the double bath process. The latter produces the finest leather, but the former is both cheaper and simpler to work and has been adopted in Madras exclusively as it yields sufficiently good results, and with the unskilled labour available there is much less risk of anything going wrong.

To secure uniform results and to save tanners, who are not chemists, from the risks of buying their own chemicals a number of tanning liquors have been put on the market ready for use. Experiments on a fairly extensive scale were made with two of these—one the well-known Tanolin, which was supplied to us by the Martin Dennis Chrome Tannage Company of Newark, New Jersey, and the other by Messrs. Lepetit Dollfus, Gansser of Milan whose Chromo-Chrome produced excellent leather. With both the results were quite satisfactory, but the leather was no better than that made using the very simple process described by Professor Procter on page 212 of his principles of Leather Manufacture. The tanning solution is made by dissolving 10 lbs. of chrome alum in 4 gallons of water. To effect the solution readily the alum should be crushed to a fine powder. Between 3 and $3\frac{1}{2}$ lbs. of ordinary washing soda is dissolved in water and slowly added to the solution of alum. Rapid effervescence takes place and the mixture should be thoroughly stirred. If too much soda is added, a heavy precipitate is formed and there is a waste of valuable chemicals. The chrome alum costs in Madras Rs. 13-8-0 per cwt. or roughly 2 annas a pound and one pound of chrome alum is sufficient for the production of 3 lbs. of finished leather. The carbonate of soda costs Rs. 7-8-0 per cwt. equivalent to slightly more than one anna a pound and as only one pound of washing soda is required for 10 lbs. of leather, it will be seen that the total cost of the chemicals employed in the tanning solution is very small and is actually less than that of the bark used in the ordinary processes of tanning. The tanning solution prepared in the above proportions contains 25 per cent. of chrome alum and is used as a stock solution. By diluting it with water solutions of any strength are readily prepared.

Usually tanning commences in a one per cent. solution and ends in a solution the strength of which is about 5 per cent.

The tanning is done in the drums already described and usually about 500 or 600 lbs. of pelt are put in each drum. The drums are arranged in a series through which the hides pass, first entering the drum containing the weakest solution and finally passing out of that containing the strongest. To the tanning liquor in the first drum about 15 lbs. of sodium sulphate are added to prevent the formation of a drawn grain. The time occupied in completing the tanning processes depends upon the thickness of the hides. Sheep and goat skins are tanned in a few hours, cow hides in from one to three days, whilst the thick buffalo hides used as sole leather take from a week to ten days. The process could be quickened considerably if the drums were worked by night as well as by day and it is probable that it would also be shortened if power were employed to drive the drums at a faster speed and continuously. The hides are considered to be tanned sufficiently when the blue colour produced by the chrome liquor has penetrated right through the hide and there is no white streak in the centre. Experience seems to indicate that there is considerable danger of producing bad leather by over-tanning and that where the hides are of very unequal thickness in different parts they should be rounded off as much as possible before being put in the tanning drums. Leather which has been over-tanned soon becomes brittle and useless and it is impossible to emphasize too much the necessity for care at this stage. As soon as it is decided that the tanning is complete, the hides are removed from the solution and spread out, one over the other, on a wooden horse where they are allowed to soak and drain for 24

hours. The tanning liquor remaining in the hides contains a considerable percentage of sulphuric acid and it is absolutely essential that this should be completely removed or the leather will perish in a very short time. It may be here remarked that the three principal causes of the production of bad chrome leather are (1) over-liming, (2) over-tanning and (3) acid in the finished leather. It is not difficult to guard against damage arising from these causes once they are recognised, but there is no doubt that a good deal of chrome leather made, both in Madras and elsewhere, has been unsatisfactory through neglect to take proper precautions to prevent damage arising from the operation of any one or all of them. To remove the acid the hides are first washed in several changes of water and then drummed in a half per cent. solution of borax, the quantity of borax used being 3 lbs. per 100 lbs. of wet leather. Litmus paper is used to test whether or not the acid has been completely removed. When it is ascertained that the leather is free from acid it is taken out of the borax solution and well washed in several changes of water to remove any soluble salts that may have formed in the substance of the leather.

Fat-liquoring.—For leather which is not to be dyed this is the final chemical process to which it is subjected, any further treatment being of a purely mechanical nature. The "Fat-liquor" is an emulsion of oil in a solution of soap and when the chrome leather is put into this the oil is absorbed and renders the leather soft and pliable. The soap employed is made in the following way :—

One hundred lbs. of castor-oil, selected because it is both cheap and gives satisfactory results, are placed in a wooden tub and 20 lbs. of caustic potash are dissolved in water and allowed to cool. When cold the caustic potash solution is slowly poured into the castor-oil and the

mixture stirred for about quarter of an hour so as to ensure that the potash and oil are thoroughly mixed. After standing about 24 hours the soap is ready for use.

To prepare the fat liquor 7 lbs. of the soap are dissolved in two gallons of boiling water to which is added an equal quantity of castor-oil and the mixture is boiled. It is then placed in an emulsifier which consists of a cylinder made of tin plate about 3 feet 6 inches high and about 10 inches in diameter. In this works a loosely-fitting piston attached to a long handle. The piston is perforated with a large number of small holes and by working it up and down the cylinder after the mixture of oil and soap has been put in the emulsification is completed. When it is desired to produce the better qualities of leather 2 lbs. of egg yolk are added to the emulsion and thoroughly incorporated with it. When the emulsion is properly prepared it will mix with hot water without showing any trace of oil. For leather intended for water bags and rough usage it is desirable to make it absorb as much oil as possible and in practice we find that about 10 per cent. will be taken up by the leather. This gives the surface a dirty appearance but that is a matter of no consequence.

The hides are fat-liquored in a drum which has been previously heated by means of boiling water. The door of the drum is closed and the requisite quantity of concentrated fat liquor diluted with sufficient hot water at a temperature of 140° F. is passed in through the hollow axle of the drum, which is then set in motion. After drumming for about half an hour it will be found that the fat liquor has been entirely absorbed by the hides which are removed and laid over a wooden horse to drain for several hours. Afterwards the hides are sleeked on stone

tables and then stretched on wooden frames to dry. When the hides are dry they are taken off the frames and subjected to the staking process which gives the leather that softness which is one of its principal characteristics. This completes the process of converting both skins and hides into undyed chrome leather. When it is essential that the leather should have a good appearance, the percentage of fat liquor, which the hides are allowed to absorb, must be reduced and when the staking operations are completed a little French chalk is dusted over the grain side.

Sole leather.—The process of unhairing now employed when the hides are destined for sole leather has already been described. The tanning takes from a week to ten days and the subsequent removal of the acid has to be carefully attended to on account of the greater thickness of the leather. It seems doubtful whether the process of fat-liquoring is necessary. At present the leather is drummed in a concentrated solution of the fat liquor the proportion employed being about 5 per cent. of the weight of the sammed leather. After fat-liquoring the leather is brought into a sammed condition either by allowing it to dry naturally or by passing it between a pair of rollers. When nearly dry it is ready for stuffing. The composition of the mixture employed is as follows:—50 lbs. of Burmese paraffin, $12\frac{1}{2}$ lbs. of tallow and $2\frac{1}{2}$ lbs. of resin. For the stuffing process it is advisable to use a flat copper or aluminium dish large enough to take the biggest of the butts which go through the process. The dish should be from 6 to 8 inches deep and supported on an iron frame. Underneath a fire is placed and the mixture of paraffin, tallow and resin melted. The sole leather butts in a sammed or partially dried condition are put into the melted mixture, the temperature of which is sufficiently high to cause the air in the pores of the leather and the remaining moisture

to rapidly pass off in bubbles. The stuffing penetrates thoroughly into the substance of the leather and when all the moisture has been driven off, as is indicated by the cessation of the stream of bubbles rising from the surface of the leather, it is removed from the dish and allowed to drain. As soon as it is cold the leather is rolled under considerable pressure between heavy rollers and is then ready for use.

Dyed leathers.—Most of the leather required for boots and shoes, saddlery and similar articles has to be dyed either black or some shade of brown as the natural colour of the leather meets with but little appreciation. This adds considerably to the cost of the leather and from the beginning it was recognised that it would be desirable to devise a simple process which could be carried out without having resort to aniline dyes. Experiments in this direction have resulted in the production of a very satisfactory brown leather, prepared by subjecting the neutralised leather after it leaves the tanning solution to a superficial tannage with avaram bark (*Cassia auriculata*). The tanning liquor contains about 5 per cent. of bark and the hides are drummed in it for about half an hour. They are then removed and washed and again drummed in a solution of Bichromate of Potash, there being about 8 oz. of the salt to every 100 lbs. of sammed leather. After this the leather is fat-liquored and finished in the usual way. The depth of colour can be increased by prolonging what is practically a bark tanning process till in the extreme limit a combination tannage is produced which will be dealt with later on. The brown leather thus produced was first intended only for the uppers of cheap ammunition boots. When worked up with the ordinary leather dressings it has proved quite satisfactory for all classes of goods though some people prefer a much darker colour.

Coloured leathers for boot uppers pass through exactly the same processes as those already described but it is permissible to allow of a somewhat longer liming so as to produce greater softness and flexibility. It is best to dye the leather to the colour required after the acid has been washed out of it and before the fat-liquoring process. The dyes employed are all aniline dyes and to fix them satisfactorily the leather must first be mordanted with some vegetable tanning material. In Madras we have found avaram bark both cheap and satisfactory. The leather, after being neutralised is well struck out on the grain side and then transferred, to a drum containing the decoction of bark, of which about 5 per cent. on the weight of the sammed leather is employed. The temperature should be about 140° F., and the drumming should last for about half an hour. The leather which will then be of a light yellow colour is removed and washed in several changes of water after which it is spread out on the sleeking table and thoroughly struck out on the flesh side so as to remove as far as possible all surplus moisture. The leather is now ready for fat-liquoring, about 5 per cent. of which is used on the struck out weight of the leather. The fat-liquoring is done in a drum at a temperature of about 160° F. and when all the oil has been absorbed, the hides are taken out and piled on a table where they are allowed to gradually cool down. Each hide or skin is dipped in hot water and then well struck out on the grain side so as to remove all the surface grease which, would make the subsequent dying uneven. With the enormous number of dyes now available any colour and almost any shade of that colour can easily be produced by using suitable combinations.

The dyes we employ are mainly of English manu-

facture being phosphine substitute, new acid green, azoflavine R and acid green. The proportion in which they are mixed depends upon the colour required and as typical mixtures the following are given :—

(1) 4 oz. of phosphine substitute and 1 oz. of new acid brown.

(2) 3 oz. of phosphine substitute, 3 oz. of new acid brown and $\frac{1}{4}$ oz. of acid green.

(3) 4 oz. of phosphine substitute and 3 oz. of new acid brown.

(4) 5 oz. of phosphine substitute, 2 oz. of new acid brown and one-fifth oz. of acid green.

These quantities are for a dozen average sized skins. The total quantity of dye stuff required varies with different classes skins, about half an ounce being required for a sheep skin and a little over an ounce for a light cow hide. The aniline dyes are dissolved in boiling water and the solution is filtered to remove any suspended impurities. The dyeing is done in drums at a temperature of about 150° F. About half the quantity of the dye stuff is used at the outset and the rest is added after about a quarter of an hour. At the end of another 30 minutes three-fourths of the dyeing liquor is run out of the drum and egg yolk added to the extent of about 1 per cent. on the struck-out weight of the leather, after which the drumming is continued for another 20 minutes, when the goods are removed, hosed up and struck out. The skins are stretched on boards or frames to dry and the grain side is lightly rubbed over with a solution of 20 per cent. of glycerine in water. Before the skins are quite dry they are removed, being then in a good condition for staking. After staking the colour may be improved by topping with a half per cent. solution of the dye used warm and applied with a soft brush. When this is done the goods should be again

staked and then finally dried right out so as to be in a condition to receive a coat of seasoning.

Seasoning.—This is made by taking 3 oz. of white of egg and one pound of milk and making up with water to one gallon adding sufficient of the dye solution to tint the mixture. The seasoning is applied lightly on the grain side and when the goods are sufficiently dry they are glazed in a pendulum machine and afterwards re-staked and then the seasoning and glazing processes are gone through a second time, at the end of which the leather is ready for use.

Blacks.—Experiments with aniline dyes such as Corvoline B. T. using Cutch as a mordant have not been very successful and we have obtained better results with Haematin or logwood extract followed by the application of ferrous sulphate. About $1\frac{1}{2}$ per cent. of logwood extract, calculated on the drained neutralised weight of the leather, is dissolved in water, to which is also added a quantity of washing soda equal to about one-eighth of the weight of the logwood extract. The leather is first drummed in this solution and in about half an hour obtains a deep blue-black colour. The goods are then removed from the drum and sleeked well on the grain side and "pleated;" *i. e.*, the skin is laid on the table, doubled down the ridge with the flesh side inside and the shanks and belly are sleeked over so as to stick them together the idea being to keep the flesh side protected from contact with the iron solution through which the goods are now passed. This consists of a 1 per cent. solution of ferrous sulphate through which the skins are pulled twice and then immediately washed in hot water and struck out. The iron in the ferrous sulphate acts upon the small quantity of tannin present in the logwood extract and turns the blue-black shade into a thoroughly good black. It is

necessary to carefully remove any excess of ferrous sulphate that the leather may contain or the process of fat liquorising will be unsuccessful. This operation is identically the same as for brown leather and need not be described again. The seasoning for blacks should be of the following composition :—

Two oz. of logwood extract is dissolved in a quart of hot water and allowed to cool and $\frac{1}{3}$ oz. of ferrous sulphate in a quart of cold water. One pint of blood, 1 pint of milk and $\frac{1}{2}$ oz. of glycerine are mixed together and diluted with one quart of water. To this the logwood extract solution is added and the whole well stirred. Finally the ferrous sulphate solution is added and the whole made up to one gallon with water. The mixture is applied with a sponge and the goods glazed for the first time whilst very slightly damp. The staking, seasoning and glazing may with advantage be repeated after which the leather is ready for the market.

Combination Tannage.—For some purposes chrome leather is distinctly inferior to well tanned bark leather and it is possible by subjecting the hides to both processes to obtain a material which possesses in a marked degree the good qualities of both tannages. The production of such leathers will of course be much more expensive than when either process is used alone.

There are three ways of carrying out a combination tannage. Either process may be carried out first, or the two tanning liquors may be mixed together and allowed to act simultaneously. Most excellent leather has been produced by purchasing from local tanners hides and skins which have been lightly tanned in avaram bark but not subjected to any process of dyeing with myrobolams or stuffing with grease. These lightly tanned kips or skins were chrome tanned in the usual way and either finished in their natural colour or

dyed brown or black. The leather has proved very suitable for many purposes and as the natural colour is a not unpleasing brown it does not really cost anything more than ordinary chrome leather dyed brown. In a similar way sole leather has been made from combination tanned hides, but there has not yet been time to ascertain whether there is any very marked advantage in the process. For highly finished boots it can certainly be employed as it lends itself more readily to a neat finish than does ordinary chrome sole leather.

Experiments have also been made in which the hides are first subjected to the chrome process and then tanned in an avaram bark solution. As already mentioned this process has been largely employed, more with a view to dyeing leather than to materially altering its properties, and so far it has proved perfectly satisfactory. Experiments with a more prolonged vegetable bark tannage have not been satisfactory and at present it seems doubtful if this order of tanning will be able to compete with that in which the vegetable process takes precedence. Tanning with mixed solutions has not yet been tried.

Conclusion.—The processes of chrome tanning which we follow in Madras have been described in the above general terms, not because there is any novelty about them, but because there is prevalent in India an idea that chrome tanning involves the introduction of machinery on a large scale and methods of operating better adapted for employment among more advanced communities. Whilst the trade in hides and skins is in a flourishing condition the art of tanning in India, except in a few tanneries, is in a deplorably backward state. In the Madras Presidency, where the tanned skin trade represents the highest development of native tanning, nearly all the best skins are bought up and exported to Europe or America in a raw state. Last

year the average value of each raw skin exported was Rs. 1-12-0, whilst the average value of tanned skins was only Rs. 1-3-0. The report of the Committee of the Society of Arts on leather for book-binding condemned East-India skins tanned with avaram bark as being the worst and most unfit from which to manufacture book-binding leathers. This was not due to any defect in the skins themselves but solely because avaram bark contains catechol tannin and experiments have clearly demonstrated that to secure the necessary durability in leather bindings those only can be used which have been prepared with a pyrogallol tannin. The effect of this report has been to restrict the market for Madras tanned sheep and goat skins and to encourage the export of all the best skins in the raw state. Myrabolams and divi-divi both yield excellent pyrogallol tannins. The former are already exported on a large scale and it would probably be wise to ascertain whether these natural products of the soil could not be utilised, not so much to bolster up a moribund industry as by a re-arrangement of ideas, to create a new one. The hides and skins of the domestic animals of India have come to be an important asset and it seems desirable that the most that can be made should be made of this national source of wealth. The abolition of the crude system of branding cattle which now prevails would probably add fully a crore of rupees to the value of the exports of hides and the abolition of the village tanner would even lead to greater results. It will probably be a long time before the people can be induced to abandon branding, but the gradual extension of the chrome process and the keener demand for raw hides, which the enhanced value of leather now enables dealers to offer, will do much to improve the methods of realising the real value of hides and skins.

CHAPTER VIII

HAND-LOOM WEAVING

I

WEAVING IN INDIA*

It is now nearly two years since I first had the pleasure of meeting the members of the South Indian Association and addressing them on industrial subjects, the discussion of which was one of the objects with which the Association was formed. On that occasion I brought to your notice the experimental work which was going on at the School of Arts in connection with the development of the manufacture of chrome leather, and I sketched out a plan for developing this industry with indigenous capital to be subscribed by shareholders in a Limited Liability Company. My suggestions, however, fell on barren ground, and as an Association I received no help from you in what, after all, was a well-meant attempt to induce people in India to make a better use of one of their raw products than they now do. Nor so far as I know has any one else met with better success—you have welcomed lecturers upon various subjects connected with Indian industries and have doubtless been interested in their enthusiasm, but they have not aroused you to action, and I am not sanguine that this afternoon anything I have to say will meet with a better fate. I have purposely indulged in this mild diatribe not because you are any worse

* A lecture delivered at the South Indian Association, Madras.

than your neighbours, but because I wish to draw prominent attention to the fact that, although during the last two or three years there has been an enormous amount of writing and talking about the regeneration of Indian industries and much enthusiasm has been aroused over the expression 'Swadeshi,' yet little or nothing practical has come of it, and I think I am stating what is a literal fact when I say that two years' political agitation has done absolutely nothing whatever to further industrial progress in India. The Swadeshi movement, though perhaps not generally known by that name, was steadily gaining ground before it was dragged into prominence by the fervid politicians who have arisen in these later days and ask to be entrusted with the control of the destinies of India. These gentlemen are asking for power, and to demonstrate their capacity for achievement have voluntarily taken upon themselves to create a new industrial India. The undertaking is no light one, and their fitness for power may well be judged by the success with which they accomplish their self-imposed task. It will demonstrate to the world at large that they are able to do something more than criticise, that their capacity for production extends beyond the manufacture of verbiage, and that they are capable of the self-sacrifice and sustained effort which is necessary to achieve great objects in the face of unusual difficulties. I do not for a single moment deny the fact that India is making considerable industrial progress but, having perhaps more than average opportunities of seeing what is going on in various parts of India, I can confidently assert that the Swadeshi movement and the Bengal methods of boycott have so far done nothing to advance the material interests of the country. Much work is going on and not a few people are earnestly labouring to reduce the pressure of the population on the soil, and the success

which has been obtained if not sufficient to engender enthusiasm, warrants further efforts in the same direction.

Not long ago I received from the Editor of a local monthly review a request to furnish him with a note setting forth the reasons which in my opinion have prevented the Swadeshi movement from accomplishing anything of real practical importance. Possibly some of you may think that this gentleman has been rather previous in acknowledging the failure of the so-called national movement, but for myself I think he is rendering you useful service in frankly acknowledging the existing state of things, and in endeavouring to ascertain whether any remedy is to be found by setting to work again on new lines. The discussion which he is endeavouring to excite covers an extremely wide field and touches upon many very controversial topics. What Japan has done, you would like to do, and the ambition would well become a nation, provided its patriotism was sufficiently deep-rooted to ensure the strenuous effort and individual sacrifice which has been shown by the Island Nation of the Far East. It is impossible for me in the time at my disposal this afternoon to discuss these questions at any length, nor is there any necessity that I should do so because, as a matter of fact, the reasons for the failure of indigenous industrial enterprise are neither obscure nor very complex. The occasion, however, seems to me to be favourable to impress upon you one of the most important lessons to be derived from the recent financial disasters which have occurred in this Presidency and by which so many hundreds and even thousands of you have been deprived of no small portion of your savings. The accumulations of half a generation have disappeared, and you have nothing to show for them. For reasons which I need not go into, you have preferred to entrust others with your capital and have refused to embark upon

indigenous enterprises conducted by men of your own race. Much outcry has been made regarding the drain of India's wealth, but the drain of experience which is constantly going on has almost entirely escaped the attention of your political leaders. There is much industrial enterprise in India, but it is mainly in the hands of foreigners, and year by year these men retire from the country, taking with them not only some of the wealth they have helped to create, but all the experience they have been able to gain. If you wish to see India restored to the industrial pre-eminence which centuries ago it undoubtedly enjoyed, you must be prepared to recognise the changed conditions under which modern industrial activity is carried on, and you must be prepared to entrust your capital to your own countrymen. Only in this way can you gradually accumulate in this country that fund of industrial experience which must exist if you are to successfully compete against manufacturers in other parts of the world. It is thought that much can be done by sending promising young men to Europe, America or Japan to acquire a knowledge of the industrial processes which are there carried on. The results of the work in this direction are far from encouraging, mainly because the wrong class of people have been sent and few of them have stayed long enough to gain that knowledge and experience, not only of the processes of manufacture but also of the methods of conducting business, which are absolutely essential to the successful initiation of industrial undertakings. It is generally forgotten that these young men leave India, not to undergo a preliminary training or to pass examinations which may enable them to start on a definite and well recognised career when they return, but to acquire a thorough knowledge of some practical trade or industry, and they are always in too great a hurry

to do this properly. Consequently when they return and find they have to depend entirely upon their own resources, hopeless failure is nearly always the result. I need not remind you that industrial work offers few attractions to the intellectual youth of this country, and that only those who have evinced no aptitude for the studies necessary to success at University Examinations turn as a last resource to commercial and industrial pursuits. I do not say that the course which you at present pursue is a foolish one, for the circumstances of the country are such that there is but little prospect of a successful career open to those who take up industrial work. There must be a beginning to all things, and over the greater part of India no attempt has yet been made to carry on industrial work on modern lines. Everything remains as in the days when the artisan was supreme, and if improvements are to be effected, capital must be put into Indian industries, technical knowledge applied to them, and a regular organisation introduced, involving a minuter sub-division of labour with its attendant economy and efficiency. As an example of what can be done in this direction, I should like to draw your attention to the workshops of the Indian Aluminium Company, situated in the very heart of Triplicane. There you will see one of the oldest native industries in Madras working on modern lines and the most improved and up-to-date metal working machinery used in conjunction with the cheap but highly skilled hand-labour of Southern India. On a fairly large scale the experiment has turned out extremely successful—a not inconsiderable number of artisans find remunerative employment, and the capital embarked upon this venture earns very good dividends. Practically the whole of India derives its supplies of aluminium utensils from this little factory, and

the scale of production is in consequence sufficiently large to enable work to be turned out at rates with which imported goods cannot compete. The only unsatisfactory feature about the business, from a purely Indian point of view, is that the bulk of the capital does not belong to the people of this country, and as a natural consequence the supervision and management are in the hands of Europeans.

Quite recently I paid a visit to Madura, and I spent some time in enquiring into the conditions under which the dyeing industry of that town is carried on. The modern phase of this ancient industry dates back to only 1895, when Mr. K. Tulsiram, a Sourashtra of Madura, started with a capital of only Rs. 100 to dye grey yarn with alizarine red. The methods of working struck me as extremely primitive, but when I tell you that the outturn last year of dyed yarn was valued at as much as 24 lakhs of rupees, and that upwards of 250 tons of alizarine dye worth about Rs. 1,100 a ton was consumed, you will be able to form some idea of the energy and ability which have been displayed in the development of this trade. There are now between 35 and 40 dye houses in Madura. Every available open space in the suburbs of the town is utilised for drying the yarn, a process which has to be gone through some thirteen or fourteen times before the final product is obtained. I am told that the demand for the yarn is greatly in excess of the supply, and it struck me that the introduction of more capital into the industry would be attended with every beneficial results. The surprising growth of this trade in the last 10 years has been due to the multiplication of the number of firms engaged in it rather than to the growth of the pioneer firms. A very large amount of labour is employed in carrying on the operations, and the time required to carry

them out runs into weeks owing to the dependence of the dyers upon open yards for drying their yarn. The way in which the work is done affords employment to a great number of coolies and a few maistries, but for the technically trained chemist or mechanic there is no opening. I do not now propose to criticise in detail the methods of working pursued, but what I wish to draw your attention to is that they are undoubtedly wasteful of capital and prodigal of labour. The capital locked up in the drying yards represents a very large sum, and it is possible that a fraction of this amount invested in machinery would materially diminish the time required for dyeing, effect an enormous economy in unskilled labour and give employment to a few men of a higher class from whom we might expect that further developments would emanate. Mr. Tulsiram is fully aware of the direction in which it is probable that improvements can be effected, but lacking the stimulus of enterprising competitors and coming but little into contact with men accustomed to Western methods of working, he has experienced some diffidence in launching out on untried lines. This is but natural and perhaps not altogether devoid of wisdom; at any rate it is characteristic of the way in which things are done in this country, due to the marked objection which exists to converting liquid capital employed in trade into the less easily realisable forms which investment in machinery necessitates.

The regeneration of Indian industries can only be accomplished by the intelligent application of capital and by bringing to the assistance of the artisans the technical results of modern science. The day has gone by when each artisan family could be considered a complete industrial unit, and if any improvement is to be effected in the status of the indigenous industries it must follow on the

lines on which industrial development has proceeded in almost all industries all over the world. All modern progress is in the direction of a minuter sub-division of labour and the introduction of automatic appliances which render production less dependent upon manual skill and dexterity. The artisan can no longer work for himself, he is bound to co-operate with others, and his daily work must be directed by men who have received a special training to fit them to exercise efficient control over considerable numbers of hand-workers.

For the last 20 years it has been generally recognised throughout this country that the hand industries were in a decadent condition, and many futile efforts have been made to do something to resist the inevitable decay. Technical education and industrial education have been invoked to remedy matters because in other countries their necessity was obvious. At the end of the seventies we, in England, discovered that our manufacturing industries were suffering from the competition of the scientifically directed and technically trained workmen on the Continent. It was gradually realised that a successful manufacturer must go through a preliminary training to put him in a position to take advantage of the practical instruction to be obtained in workshops and factories. Technical Schools and Colleges arose to supply this demand, and at the present day it is generally admitted that the provision for technical instruction is fairly adequate. In India industries are not dying out because they have become so complicated that the old methods of training men to direct them have become inadequate; on the contrary they are gradually being extinguished because the methods of working continue in their primordial simplicity, and no attempt whatever has been made to take advantage of modern developments. At the outset this was not recognised and

the remedy called for in India was the same as that which had proved efficacious in England. Schemes to provide technical instruction were set on foot, technical institutes founded, scholarships offered and greedily accepted by impecunious youths, but gradually it was realised that there was no field of employment for the students when they had completed their training and that in fact the course of treatment was not applicable to the complaint. Time has revealed the situation more clearly, and we are now able to make a more or less correct diagnosis of the disease and to indicate the direction in which efforts must be made if any improvements are to be effected. It remains to be seen how far we can get you to readjust yourselves to the changed environment and how far the Government in this country can judiciously take a direct part in establishing new industries and resuscitating old ones.

In the Madras Presidency more has been done in this direction than in other parts of India, and as the Secretary of State has recently sanctioned the appointment of a special officer to deal with industrial and technical inquiries, it may be presumed that the work which has been done in the past has been sufficiently successful to justify its continuance and development in the future. Where the people are self-reliant and private enterprise is strong, the direct intervention of Government in industrial matters is calculated to do more harm than good. But in this Presidency these conditions do not prevail, and Government acting as a pioneer may do much useful work and determine the direction in which the capital available may be most judiciously employed.

One of the greatest difficulties, Indian capitalists experience in their efforts to start new industrial undertakings, arises from the fact that they cannot obtain disinterested

advice on technical matters, and there is no question that Government in this direction will greatly stimulate private effort if steps are taken to render it practicable for any one in this country to get expert assistance in working out new schemes. This will in part counteract the evils, which you are suffering from, owing to the lack of that fund of industrial experience which has been gradually accumulating in other countries. It would be interesting to discuss these general questions further, but this evening I have come here to tell you what has been done and what, so far as I can see, is likely to be done in the future with the hand-loom industry.

For nearly ten years the decadence of the native hand-weaver has been the subject of much correspondence and discussion in the Indian daily papers and a good deal of false sentiment has been engendered in connection therewith. The glamour of the past has blinded the friends of the weaver to the realities of the present and to a large extent the efforts which have been made to improve his position have been futile because they have neglected to take into account certain economic factors of overwhelming force. Two centuries ago Europe was scarcely on a par with India in respect to textile manufactures and the exports from India to England had much influence in bringing about that marvellous revolution in the processes of manufacture employed in the textile trades which began about a century-and-a-half ago and has scarcely been completed yet. It will not be true to say that all this while the Indian weaver has stood still ; for he also has been affected, and his methods of working to-day are an advance on those of the 18th century. Nevertheless he has been very badly worsted in open competition with the products of the power-loom of Lancashire and even where he is not

subjected to the stress of direct competition, the primitive organization of his trade places him at a serious disadvantage.

There are many fabrics manufactured in India which cannot be made with commercial success in the power-loom and in these branches of weaving, the only thing to be feared is that the hand-weaver may lose his business through changes in the tastes and customs of the people which may lead them to substitute fabrics which can be made in power-looms for those which are now made and can only be made in hand-looms. As an example of the class of goods to which I refer, I would draw your attention to the beautiful solid bordered cloths which are manufactured in large numbers in Salem and Madura. Attempts have been made to produce them in power-looms, but the article produced was not at all the same thing, and weavers of these cloths are as yet unaffected by direct competition of power-looms. These cloths are expensive and the demand for them has diminished, because other cloths of inferior quality can be produced so very much more cheaply. In the manufacture of very coarse cloths a vast amount of dungri is made from very inferior cotton on hand-looms, and those engaged in this branch of the trade have little to fear from the competition of power-looms because the material employed does not possess the strength which must of necessity be found in warps which are to be employed on such looms. The hand-loom has not died out in Europe but wherever it is found working, investigation generally shows that there are special reasons why it continues to be employed, and as these reasons are not applicable to India, they offer no encouragement to those who are endeavouring to make out a case for the vitality of the hand-loom industry. The hand-loom weaver of India still survives to the present day

mainly because there was no alternative open to him ; but in the struggle he has been reduced from prosperity to poverty and even with the assistance of his women and children, he is only just able to earn a bare livelihood. In many cases he is no better off than an unskilled labourer and in times of famine and scarcity the cessation of the demand for his cloths reduces him to complete destitution at once.

Five or six years study of the problems connected with hand-weaving has led me to the conclusion that whatever may be the ultimate fate of the hand-weaver he can easily hold his own for a long time to come, since he is content to exist on but little more than the bare necessities of life. Even as a hand-weaver he has much to learn, and if we could endow him with intelligence and energy there is no doubt that a bright future would be in store for him. The condition of the hand-weavers varies much in different parts of India, mainly because the pressure of outside competition has been felt much more severely in some branches of the trade than in others, but this alone does not account for the whole difference. In some places the local conditions are favourable to the weaver, in others the reverse, and in places where the weaver has been induced by friendly assistance and control to adopt more modern methods of working there his condition is by no means so deplorable. Climate has a good deal to do with success in weaving and much better work can be done in the moist climates of the Coast Districts than in the dry regions of the interior. In Lower Bengal the weavers not only enjoy a favourable climate, but in some of the Districts they have adopted the fly-shuttle loom, and this enables them to make a rather better living than their contemporaries who still adhere to the old-fashioned method of passing

the shuttles through the warp by hand. The efforts to improve the hand-loom industry during the last year or two have mainly been confined to attempts to introduce improved forms of loom whereby the rate of working may be considerably increased, and there is no doubt that whatever is accomplished in this direction is to the weaver's benefit, but it must not be assumed that the difficulties of the hand-weaver will entirely disappear in the presence of an improved hand-loom. In a paper recently contributed to the Industrial Conference at Calcutta it was stated :—

“The production of hand-looms working in the country is estimated at 1650 million yards. The looms work at an average effective speed at 20 picks per minute, and if this can be increased to 50 picks, the increased production with the same number of looms will be 2,475 million yards. This increase more than equals the total cloth imports to the country. As this increase can be produced by the same number of men as are now engaged on the looms, the price per yard will be cheaper than at present, and their ability to withstand foreign competition will so far be increased.”

There is a germ of truth in the above paragraph, but it is easy to exaggerate the effect of an improved loom, and it is quite certain that the mere doubling or trebling of the out-put of the hand-loom will not by itself bring about any material improvement in the weaver's condition. In the first place weaving is but one of the processes through which cotton is made to pass in its conversion from yarn into cloth, and an improvement in this one stage may have only a very slight effect upon the total cost. Between the primitive methods of warping and sizing employed by the hand-weaver, and the methods employed in the modern power-loom factory there is an immensely

greater difference in the rate and cost of production than there is between the outturn of the hand and the power-loom. Similarly between the methods of disposal of the finished goods adopted by a highly organised weaving factory and the primitive system in vogue in the bazaar, there is an equally great difference, and it can scarcely be doubted that the hand-loom weaving industry would be in a very much more flourishing state, if the hand-loom weavers could be induced to work in factories under proper supervision and organised in such detail as to reap the advantages which always accrue from a proper sub-division of labour. That there is something in this contention is widely recognised and within the last year Government have permitted me to extend the scope of our weaving experiments by opening a hand-loom weaving factory at Salem, whilst a number of purely commercial factories are being started in other parts of the Presidency. In Madura, the Meenakshi Weaving Company has been established with a capital of about one lakh of rupees, and the Proprietors are building a weaving shed at a cost of nearly Rs. 40,000. Whilst this work is going on, they are employing 70 weavers to work for them in their own homes and have supplied them with 20 fly shuttle-loom for weaving plain cloth, and 50 looms for bordered cloths, each of the latter being fitted with a system of harness for weaving patterns, which is the invention of a local weaver and is a marked improvement upon the very cumbrous system usually employed. This enterprise has been started on very sound lines, and it seems likely that the capital employed will yield a good return.

What is perhaps of greater interest to you, since it is situated near Madras, is the weaving factory in Tondiarpet which has been started by Mr. P. Theagoraya Chetty.

In this factory some experiments are now being made with warping and sizing machinery recently imported from England ; but what I should like to make clear to you is this, that the ultimate improvement of hand-weaving depends more upon the successful establishment of these hand-weaving factories than upon the details of methods of working which may yet be devised to increase their capacity.

For many years past the weaving establishments of the Basel Mission on the West Coast have been successful examples of hand-loom factories, and a careful study of the methods of management adopted by these German Missionaries will render it comparatively easy to establish native factories on similar lines. It is true that they are not run as purely commercial institutions, but nevertheless they have proved successful on the financial side. In these factories, they employ ball warping mills, the weaving is done on European hand-looms and where complicated patterns have to be woven suitable dobbeys or Jacquart apparatus are employed. I do not wish it to be implied that all has been done that can be done to improve the hand-loom machinery but what I wish to emphasise is that if full use is made of what has already been tried somewhere or other on an extensive scale, there is reasonable prospect of infusing new life into hand-loom weaving and putting the weavers themselves into a more secure position.

The difficulties which have to be faced lie mainly with the weavers themselves, and of these we have experienced a full measure in the work which is going on at Salem. There is not the least doubt that the fly-shuttle loom is from 50 to 100 per cent. more effective than the native hand-loom, but the weavers object to turning

out in a day more cloth than they have been accustomed to, and neither in Salem nor Madras have we ever been able to get them to make full use of the improved way of working. It is perhaps difficult for most of you to realise the great change which bringing the weaver into a factory system involves. He is a fairly hard-working individual, as if it were not so he would be starving, but he is accustomed to work at his own time and in his own home, and the regular hours obtaining in a factory are extremely distasteful to him. In the factory the work is undoubtedly more monotonous than in the domestic circle, and the main compensation which the weaver can look forward to is that he will have to work shorter hours and be able to earn sufficient wages to keep his family respectably, and allow them to enjoy freedom from sordid cares and anxieties which at present is very much their lot.

The establishment of hand-loom factories will afford excellent opportunities for educated young men to acquire a knowledge and insight into the principles and methods which must be pursued to enable manufacturing operations to be carried on profitably. Excepting these recently established factories, I think I am correct in saying that not a single educated man is directly employed in the weaving trade although it is by far the largest indigenous industry in this country. I am not without hope that we may see hundreds of weaving factories gradually coming into existence, and it will be difficult then to estimate the effect of the improvements which will be brought about by associating the work of the weaver with men whose intellects have been trained and who have a full knowledge of the conditions under which the weaving industry must be carried on. If this is to be accomplished it must be in the main the work of private enterprise though Government at the outset has pro-

vided the initial stimulus and, for some time to come, must exercise a preponderating influence on the way in which the weaving problem is handled. We have already, as you are aware, an experimental weaving factory in Salem, where weaving experiments on a practical scale are being carried out, where new apparatus can be tried and new ideas tested. What we lack at the present time is advanced expert knowledge in regard to the higher developments of pattern-weaving, and there is no doubt that by providing typical apparatus and bringing out a capable expert to develop its use, much good work could be done through the medium of the weaving factories already established and through those which are likely to spring up in the immediate future. I am of opinion that when the hand-weaving factory system has got fairly into motion, much good may be done not only by sending men home to study technical weaving in such schools as exist in Manchester and elsewhere, but that still more may be done by bringing out to India experts to assist private enterprise in working out new developments in the local factories. This is but an example of the way in which Government may help you out of the difficulties which have arisen from the fact that in this country you have not hitherto been able to do anything towards accumulating that fund of technical experience and skill without which it is impossible that you should make the least headway.

From all parts of India correspondents apply to me for advice regarding the establishment of hand-loom factories but without local knowledge there are only certain matters which can be dealt with in general terms.

The first question which naturally arises is on what scale hand-loom factories should be started, and this, I think, depends very largely upon the method of warping

which is to be employed at the outset. If the ordinary native methods of warping are employed, it will be practicable to make a start with 20 or 30 looms, as if properly arranged the outturn from these should give full employment to a competent manager ; and the profit on working should be sufficient to provide him with adequate remuneration including interest on the capital outlay. Machines which produce the warp in a continuous sheet, which is wound directly on the weaver's beam, as in the slasher sizing machine or machines, of smaller capacity, which produce the warp in sections to be subsequently combined and run off on to the weaver's beam, have a very much larger output, and, if the capital outlay expended on them is to be fully utilised, the weaving factory must possess from 150 to 200 looms.

In regard to the equipment of a hand-loom weaving factory, it is essential to definitely settle what cloth it is proposed to manufacture before any machinery is purchased, and then warping mills and looms should be purchased which are best suited to turn out such work. At present I cannot recommend any of the warping machines which have been recently suggested as suitable for hand-weaving factories. The superiority of hand-woven goods in this country depends very largely upon the methods of sizing employed, and machines cannot effect this operation so as to produce a result similar to that obtained by stretching the warp and brushing it by hand. This of necessity involves employing a very large number of leases, and the hand-warping machines now in use, of which large numbers may be found in the bazaars of weaving towns like Salem and Madura, do very excellent work. With good fly-shuttle looms the output of a weaving factory should be double that which can be obtained from the same number of native hand-loomis, and it is therefore desirable that much longer warps

should be employed than at present is the custom ; but at the same time care must be taken not to employ too long warps, lest the sizing should deteriorate and the threads become rotten.

Much attention has been paid during the last two or three years to the improvement of hand-looms, and a great number of patents have been taken out but I need hardly tell you that most of them are very imperfect and are never likely to be brought into practical use. Up to the present time I have not been able to discover any better loom than that which I have adopted for work in the Salem factory, and which Mr. Theagoraya Chetty has also adopted in his factory at Tondiarpet. This is practically the old English fly-shuttle loom with as few complications as possible. It possesses an automatic take-up motion to ensure regularity of picking, but in every other respect it is a non-automatic machine. Very ingenious hand-looms, or it would be better perhaps to call them foot-looms have been put on the market by one or two English firms, such as Messrs. Hattersley & Sons and Messrs. Raphael Brothers, but my experience with them is unsatisfactory. They are really power looms adapted for working with treadles or pedals. They are complicated, expensive and much too heavy for the ordinary weaver to drive. A high rate of picking can only be obtained either by the use of a very light shuttle or by the expenditure of considerable power, and in a successful hand-loom it is desirable to adopt a middle course and make the rate of picking such that it can be kept up with a fair amount of regularity throughout a working day. The effort required to drive the shuttle backwards and forwards through the warp is very fatiguing in the English hand-loom and the weaver only keeps going because he has frequent interruptions which enable him to rest his arm, and there is no practical

advantage in introducing devices which will lessen the period of these interruptions beyond that which is necessary to the weaver to enable him to keep going. If the weaver can throw his shuttle effectively for half the time he is at the loom, the result may be considered satisfactory. In the English hand-loom the throwing of the shuttle and the beating up of the west are two independent operations and naturally inventors endeavour to combine them and thus render the working of the loom much simpler. This is done in the Japanese hand-loom and in the very ingenious loom designed by Mr. Churchill of the American Mission at Ahmednagar. In both these looms the picking strings are done away with, and the picking is effected by a mechanism worked from the slay which comes automatically into operation in the process of beating up. The Japanese loom is too much like a power loom to be suitable for a hand-loom weaving factory, and Mr. Churchill's loom is unfortunately defective in the mechanism for timing the throw of the shuttle, and in practice we have found no advantage in its use when the cloth to be woven was more than a yard wide. These defects Mr. Churchill has been the first to admit, and only recently he wrote to me saying that he was still at work endeavouring to produce an effective hand-loom. The problem is a very difficult one, and his disinterested labours will be watched with interest, for there is no doubt that if he succeeds in producing a hand-loom which will work as effectively on wide warps of high counts as the Ahmednagar loom now does on narrow warps of low counts, the benefit to India and to the weaving population will be very considerable.

In conclusion I should like to briefly sum up the view of the situation which I have endeavoured to place before you. It is this, that the amelioration of the con-

dition of the hand-weavers in India depends upon the introduction of the factory system and the organization of the labour available in a more efficient manner. This will necessitate the employment of capital and will find occupation for a considerable number of highly trained young men. The weaver will have to be educated, and his lot will be improved only when his services become more valuable. Only those who have tried to manage hand-weaving factories can form any adequate idea of the difficulties which have to be faced, and I commend to your attention the extremely valuable work Mr. P. Theagoraya Chetty has done in Tondiarpet.

II

THE SALEM WEAVING FACTORY.*

In the present paper I propose to give a brief account of the origin and objects of the Hand-loom Weaving Factory which was established early last year in Salem under the orders of the Government of Madras. This Factory has attracted a great deal of attention not only in the Madras Presidency but in all parts of India, unfortunately however its aims and objects have been misunderstood with the result that the work done there has not exercised that influence over the movement in favour of reform in the methods of the hand-weaver which we think it is entitled to and which in the interests of the Indian weavers themselves it should.

As far back as the year 1900 my attention was drawn to fly-shuttle looms as an improvement over native hand-looms by the then Deputy Superintendent of the Chingleput Reformatory and in the following year I set up about half a dozen fly-shuttle looms in a shed in the School of Arts, Madras, with the object of getting experience as to

* Contributed to the Industrial Conference, Surat, 1907.

their working capacity and data regarding their possibilities. I was aware of the existence of the large weaving establishments on the West Coast belonging to the Basel Mission where fly-shuttle looms are exclusively used and, as Inspector of Technical Schools in Madras, I knew of a number of mission institutions where weaving with fly-shuttle looms was taught. But in every case the work was with comparatively coarse counts and the goods turned out were invariably copies of the Basel Mission work. So far as I was aware no attempt had ever been made to turn out purely indigenous cloths on fly-shuttle looms and it was to achieve this object that I began the investigations. From enquiries in Madras I found that some attempts had been made by people interested in the piece-goods trade, but that nothing had come of them and a Muhammadan firm, Messrs. Hajee Mahomed Badsha Sahib & Co., showed me the results of a very extensive series of experiments they were undertaking in the manufacture of Madras handkerchiefs with the domestic hand-loom manufactured by Messrs. Hattersley & Sons. When their experiments ended in failure they lent me some of the looms with which to make further experiments and these looms may still be seen in the School of Arts, Madras, among the discarded relics of our various weaving experiments.

At the outset Madras handkerchiefs were taken up and for two or three years we made great efforts to improve the various details of their manufacture in the hope of being able to turn them out at a profit. At first the handkerchiefs fetched poor prices, but latterly we were able to command the highest rates paid for them. Attempts were also made to introduce the manufacture of these handkerchiefs into some of the Industrial Schools, but in every case the experiment ended in failure and at

the end of 1905 after carrying on the work for nearly five years it was found impracticable to make the fly-shuttle loom a success on the lines along which we were working. We had, however, definitely ascertained that it was practicable to turn out a much larger percentage of cloth on a fly-shuttle loom than on the native loom, that a cloth of even better texture could be produced and that if the sizing processes could be improved there seemed to be some hope of the fly-shuttle loom coming into general use throughout the country. Our want of success was partly due to trying to do too many things at one time but mainly to the difficulty of getting good weavers to work regularly in the weaving shed.

In August and September 1905, I made a tour through Bombay, the United Provinces and Bengal and in passing orders on my report the Government of Madras expressed their willingness to establish a hand-loom weaving factory for experimental work either in Salem or Madura. For a variety of reasons the former town was selected and in February of last year the looms and apparatus with which we were working in Madras were transferred to Salem and a new start was made. Salem was selected, because according to the Census Reports there were over 8,000 hand-weavers in the town who were supposed to be in a more or less chronic state of poverty, because the climate was considered suitable, and finally because it was conveniently situated in regard to access from Madras—a matter of some importance in connection with the supervision of the factory. All the experience gained in running the looms in Madras was made use of in considering the lines upon which the Salem Weaving Factory was to work.

In a report on the results of the first year's working of the factory which was submitted to the Government of Madras I have explained that it is an experiment to ascertain

whether it is possible to improve the condition of the hand-weavers in Southern India.

(1) by substituting for the native hand-loom improved hand-looms which will enable the weaver to produce a greater length of cloth in a given time without in any way sacrificing the essential characteristics of native hand-woven goods ;

(2) by introducing the factory system among the weavers so that they may work under the management of men with commercial and manufacturing experience and so that capital and organisation may be introduced into the industry to render the hand labour more productive ;

(3) by introducing, if possible, improved preparatory processes to diminish the cost of the preliminary warping and sizing which the yarn undergoes before it is placed in the loom.

From this it will be seen that the Weaving Factory is not a school for imparting instruction in the trade, but is simply for solving certain problems which have been definitely formulated and the future action of Government in regard to the weaving industry will largely depend upon the solution which is arrived at. With the first set of problems and the third set no one, I think, will disagree, but a great deal of opposition has been raised to what is characterised as an attempt to introduce the factory system with its assumed squalor and ugliness into what is deemed an artistic handicraft. If the hand-weaving industry is to be materially improved, a great deal has to be done not merely in connection with the technical details of the weaving processes, but also in connection with the training and education of the weaver himself. In the design of woven fabrics there is immense scope for artistic skill, but the production of these fabrics

in the loom is a purely mechanical operation and the hand-weaver is an artisan and not an artistic handicraftsman. The production of solid bordered cloths is still beyond the capabilities of the power-loom and for the very finest work the native hand-loom is still supreme ; but for the bulk of the textile fabrics required by the people of India the power-loom is one method of manufacture and the question which has yet to be answered is whether or not it will ultimately be the only method of manufacture.

Those who study the weaver in his house amid his ordinary everyday surroundings, often short of work and nearly always in the hands of the cloth merchants in the bazaar, see little of the independent artisan who is to be the industrial backbone of this country, but much of the misery and poverty of his lot. With the assistance of his women and children he ekes out a miserable existence and his seeming independence is merely indolence and aversion to regular work. The imagination of the artist casts a glamour over the wretched isolation of the weaver and would have us leave him to fight a losing battle against the products of one of the largest and best organised industries in the world, telling him to work with tools which have been discarded in other countries as inefficient. The purchasing power of money in India is steadily decreasing and in most of the other trades and industries the earnings of the workers are increasing. In the weaving trade at best they are stationary and in many places are on the decline. Will the hand-weaver survive the stress of competition or will he be driven as in other countries to seek a livelihood at other work ? The answer is doubtful. The fact that he has survived so long is in his favour and there is no doubt the transitional period can be prolonged, but it is still an open question as

to whether he can be put in a position which will enable him to command the same wages for the same number of hours of work as the power-loom weaver, or the blacksmith or carpenter, whose industrial existence is not threatened by the prospect that ingenious machinery will be devised to supplant them. On all these questions, I have in respect to the weaving factory endeavoured to preserve an open mind and it has only been called a factory and organised on factory lines because it seemed to be the simplest way of testing the efficiency of new methods of working and of training a certain number of weavers to carry on industrial experiments to a definite commercial conclusion. As a Government institution one can hardly hope that it will be a great commercial success. Experimental factories cannot be run on purely commercial lines and there is no chance of establishing any sort of a monopoly which might enable us for a time to obtain unusually profitable work.

So far at Salem we have not had time to tackle any technical problems connected with the hand-weaving industry. All our time has been engaged in getting together a sufficient number of capable hand-weavers to really test the capacity of the various looms which have been brought to our notice. We have found that the hand-weavers of Salem like the hand-weavers of Madras object to working in factory, and although their wages are good their attendance is unsatisfactory. This is mainly because the weavers prefer to work in their own homes, assisted by their women and children, and dislike being subjected to the discipline and regular hours of working which must necessarily prevail in the factory. Although the men can earn considerably more than they do in their own houses and are ensured regular and continuous employment, they

much prefer the old system and seem to find steady employment extremely irksome, but few of them are free agents and nearly all are in the hands of the cloth merchants who from time to time make them advances and receive the cloths they manufacture. Naturally these gentlemen view the experiments at the Weaving Factory with suspicion and their influence has all along been against us. So far, therefore, we have had to work mainly with the waifs and strays of the weaving community, and the Assistant in charge of the Factory has had a long and tedious task in getting it into even some semblance of order. Private individuals however have watched our efforts, imitated our methods and without any special advocacy on our part a considerable number of hand-weaving factories have been started in various parts of the Presidency, but with what degree of success I am not able to state.

The interest in hand-weaving is mainly due to the Swadesi movement and most of these factories owe their existence to the enthusiasm engendered at the birth of a new political movement. Whether, in the long run, they will hold their own or not, and whether, in consequence, they will grow in size and multiply in number, remains to be seen. Comparatively recently there has been a great development in the use of cotton checks for native clothing and it is largely to supply this demand that most of the factories were started. The pioneer work in this direction was done by the Basel Mission weaving establishments and it is not improbable that if the demand continues to grow to any great extent the power-loom weavers will try to cut into the business and possibly with success. In Madras, at any rate, there are two large hand-weaving factories in Tondiarpet, both of which are manufacturing Madras handkerchiefs and in this direction the proprietors assure me that they are

doing better than with native hand-looms, but as no accounts are available it is difficult at present to tell whether they have succeeded in placing these factories on a firm commercial basis, or whether they have achieved little or nothing more than has been done in the Government Weaving Factory.

I freely invite criticism of our methods of working and of the way we are tackling the weaving problem, but I deprecate all criticism which is based on ignorance of our local conditions. In Conjeeveram, a large weaving centre, at no great distance from Madras, the National Fund and Industrial Association have endeavoured to popularize the fly-shuttle loom and I have assisted their efforts in so far that I have lent them six fly-shuttle hand-looms, but the experiment has not been productive of any satisfactory result and the National Fund and Industrial Association have failed to popularize the fly-shuttle loom notwithstanding the fact that they fully recognise its merits. Similarly in the town of Madura where the weavers are more enterprising than in most parts of the country numerous experiments have been made with fly-shuttle looms and I have seen the most improved types of European hand-loom such as the domestic loom of Messrs. Hattersley & Sons at work in the bazaar, but none of these looms have caught on and plain weaving to-day is done in Madura much in the same way as it was more than a hundred years ago. It is not the expense which a good fly-shuttle loom entails which stands in the way, for in places where looms have been lent there has been no eagerness on the part of the weavers to avail themselves of the loan. Finally our experience in Salem itself is dead against any idea that the fly-shuttle loom can be popularised among the weavers themselves. On the other hand in the Guntur and Krishna Districts

there are signs that the weavers are beginning to take to the fly-shuttle. It was first introduced to their notice at the *Vetapallyām* weaving school and it is certainly now largely used in the neighbourhood of *Masulipatam*.*

In connection with weaving in fly-shuttle loom the opinion has hitherto generally prevailed that fine cloths cannot be woven on looms fitted with the fly-shuttle attachment, because owing to the greater strain only comparatively coarse yarn which will not readily snap can be used for the warp. This opinion has absolutely no foundation in fact, as where the fly-shuttle looms are designed for working in fine counts no difficulty has been experienced. The great bulk of the work done in the *Salem Weaving Factory* is in counts between 60's and 100's and I should not have the least hesitation in undertaking work in higher counts if the orders were sufficiently large to make it worth while. The fly-shuttle loom, no matter what type, must be constructed to suit the work for which it is intended and a loom which may do very well for dungries or checks may be unsuited for fine counts and it is mainly owing to the neglect of this point that fly-shuttle weaving has made so little real progress among the Indian weavers.

From the time when these experiments in weaving were first started a great deal of attention has been paid to the various forms of loom which have been placed on the market and any pattern which offered the least promise of

* A recent detailed enquiry (December 1911) has established the fact that there are now nearly 10,000 fly shuttle looms in use in the Coast Districts to the North of Madras and that the adoption of this method of weaving has greatly improved the condition of the weavers. In many respects the people on the East Coast seem to be more susceptible to the influence of new ideas than in other parts of the country. Evidence of this may be seen in almost universal use of aluminium in place of Brass and copper, in the numerous small factories which have been started and in the extensive use of oil engines and pump for irrigation.

success has been thoroughly and carefully tried and I propose briefly to state the results of the observations. Work was started on hand-looms of the pattern generally found in mission schools in the south of India and it was found in such looms that although fly-shuttle enabled the rate of picking to be greatly increased yet the increased time spent in mending broken threads in the warp almost entirely nullified its advantages. One by one the defects of this loom were remedied, the proportions were changed, the warp beam was mounted on springs, an automatic take-up motion was introduced and the picking string carried over a guide pulley with the result that at the present time it can hold its own in fairly fine weaving against any loom which has so far been brought to my notice. In this loom there is nothing absolutely novel. It has simply been proportioned in its various parts to suit the work to be done and care has been taken to prevent it becoming complicated. For instance whilst we were engaged in making Madras hand-kerchiefs in which several colours are used in the west it was thought that possibly the English drop box might prove a convenient addition to the slay but in practice it was found to be no great advantage and the use of the drop box was discontinued. In the English hand-loom, as in the native hand-loom, the picking motion is independent of the treadles which control the shedding motion and the weaver must learn to jerk the picking string with his hand when he has opened the sheds sufficiently by the levers controlled by his feet. The loom is in no sense automatic, but it is possible when the picking strings are carefully adjusted to make from 80 to 100 picks per minute through a warp 54" wide. At the present time at the Salem Factory, where we use nothing but country warps sized by hand, to avoid frequent stoppages

to shift the lease rods a fairly long spread of warp between the warping beam and the healds is necessary. This makes a long frame necessary and the loom takes up a lot of space which is in some ways a serious disadvantage.

It became obvious at a very early stage in the experiments that the fly-shuttle slay could be used in the native hand-loom, and that we could improve the rate of picking. I am not now certain to whom the credit of first making this suggestion is due, but it is a very important one, as it places in the hands of the native weaver a very great improvement in his loom, and one which can be obtained at a very small expense. This modification has been largely tried and with considerable success, but it does not secure all the advantages of the frame loom pattern and is to be regarded rather as an intermediate stage between the Native and the English loom. Experience has taught us that the greatest defect of this loom is the number of broken ends which occur in the process of weaving, and these have been much reduced by putting the warp on an elastic frame and by using brass reeds and healds with metallic eyes. The healds and reeds we employ are obtained from Messrs. Jones Brothers of Blackburn, England, through their agents Messrs. Huthéesing & Co. of Bombay. They are considerably more expensive than native healds and reeds, but those who have given them a fair trial consider that they are worth the money. It is not an uncommon custom for native weavers to vary the closeness of the texture of their cloths by using reeds set much closer together near the edge of the cloth than in the middle. The practice, if not actually fraudulent, is not to be recommended, as it is calculated to deceive the unwary, but it is widely in vogue and is likely to render English reeds unpopular un-

less they are made to conform to this practice. The automatic take-up motion is not an essential feature of the loom, nor is it a very popular one with native weavers, but it enables the weaver to produce cloth of a perfectly uniform texture. The cost of this loom varies with the amount of timber put into it, the quality of the timber and the general style and finish. Complete with English healds and reeds it will not cost more than Rs. 100 and in large numbers can be produced for a somewhat smaller figure. In our experimental workshops we have made a good number of these looms and we sell them, exclusive of healds and reeds, for Rs. 85 each. These looms are purchased more as patterns to be copied than as actual working looms and our price is perhaps somewhat high.

I do not propose to furnish a dissertation on weaving mechanisms, but before discussing the results obtained with other types of loom it may well to explain that in all the improved hand-looms mechanism is provided whereby the picking and shedding motions are combined, and the weaver is reduced to a pure automation who either works the loom through a pair of pedals or sets the mechanism in motion by causing the slay to swing in pendulum fashion by one or both hands. The weaver is a mere automation so long as everything works well, but if anything goes wrong or if the driving force he supplies is insufficient a break down always occurs and his skill as a weaver will be called into play in repairing the damage done.

During the last few years the discussions about the hand-loom weaving in India have led many people, competent or otherwise, to attempt the improvement of the hand-loom, and many worthless patents have been taken out. During the last six years I have had under observation every loom, that I have heard of, which seemed to offer the least prospect of turning out successful, and

the following is, a complete list of the looms which have been tried :—

- (1) The Domestic hand-loom of Messrs. Hattersley & Sons.
- (2) The Domestic loom of Messrs. Raphael Brothers.
- (3) The Japanese hand-loom.
- (4) Mr. Churchill's loom (Ahmednagar).
- (5) Captain Maxwell's loom (Salvation Army).

I had the Hattersley's looms at work for a long time on a great variety of fabrics, made from yarn of counts up to 40's, but the output was never satisfactory, as the work of driving the loom was far too heavy for the native weaver. For a time I tried them with two weavers for each loom, so that when one worked the other rested, and this naturally increased the output but not to the extent that was to be expected. When the loom is driven at a perfectly uniform rate, it works very satisfactorily, but when the source of supply of power is an Indian weaver the supply is very irregular and the result unsatisfactory.

The Raphael loom was never actually at work in either the Madras or the Salem weaving shed and my knowledge and experience of its working is gained by observations made on the loom purchased by Mr. Theagaraya Chetty of Tondiarpet. This loom suffers from the same defects as the Hattersley's loom and is much too hard work for the undeveloped legs of the Indian weaver. To all intents and purposes both these looms are power-looms and better work will be got from them if the treadles or pedals are done away with and an arrangement made to drive them off a line of shafting. The looms are made of cast iron and it is astonishing how easily the castings are broken and how helpless the Indian weaver is in face of even a simple fracture. These looms are totally unsuited for individual weavers working on

their own account, and I fail to see what advantage there is if they are gathered in large numbers in a factory and human labour is employed to drive them. Thirty or forty such looms can be driven by a small oil engine costing not more than Rs. 4 or 5 a day to run and there is not the least doubt that the output of these looms will be three or four times as much as when worked by hand-labour. I am inclined to think that small power-loom factories of this type might be worked with great success in this country and would afford an admirable training ground for the development of indigenous manufacturing genius. I am now dealing with hand-weaving and it will be out of place to discuss this suggestion any further, but I think that small power-loom factories would prove very successful if properly designed and worked on the right lines.

With the Japanese hand-loom my experience was very unsatisfactory. It was obtained from Mr. Shafi through the Ludhiana Loom Manufacturing Company and was found to be a crude and ill designed loom and no warp ever put into the loom was woven into a satisfactory cloth. Why the loom was brought from Japan to India I do not know and the sooner it sinks into the obscurity from which it was dragged the better. I have been told by Japanese connected with the weaving trade that the loom is not used in Japan and I am not surprised as at the best it is only suitable for very coarse work.

Mr. Churchill's loom.—When I visited the American Mission Industrial School at Ahmednagar in 1905, Mr. Churchill showed me a number of his looms at work on a kind of dungri, and I was much struck with the results obtained when weaving this kind of cloth. Subsequently Mr. Churchill built 6 looms for the Salem Weaving Factory to weave fine cloths from 45" to 54" wide. On such work the loom has not been a success and the Salem weavers

object to it. The mechanism for timing the throw of the shuttle is defective and the shuttle is very liable to be caught in the warp when it is more than a yard wide. To make the shuttle travel properly the slay has to be moved forward with increasing rapidity and then suddenly brought to rest, and on the finer warps the percentage of broken threads renders the output of the loom much smaller than would be anticipated from the rate at which picking can be done when the warp is not too wide.

The last loom with which we are still experimenting at Salem is that invented by Captain Maxwell of the Salvation Army and known as the "Triumph" loom. I have only one of them at work at Salem, with which fairly satisfactory results have been obtained and a second loom has been ordered with some slight modifications which it is hoped will improve its outturn. If this anticipation is realised, it is proposed to put down six more looms and to thoroughly test them on the same class of work against six looms of the English pattern already described.

In the looms of both Churchill and Maxwell the driving force is applied to the slay and I am inclined to think that, whilst this will work satisfactorily on coarse warps, the necessarily somewhat jerky motion of the slay is not conducive to a good output when the warp is fine. Personally I hold the opinion based on over six years' experience with different types of hand-loom that, when the power-loom is converted into a hand-loom, it becomes an unsatisfactory machine owing to the irregularities in the driving force and that the hand-loom must be a simple piece of mechanism in which the irregularities of the weaver are compensated for by the gentleness of the action of the loom.

A power-loom will make from 200 to 250 picks a minute, and from careful observations made of the

outturn of hand-looms I find that the daily average has only in one instance exceeded 30 picks per minute and when weaving fine cloths an average of from 20 to 25 picks a minute may be considered very good work.* Mr. Churchill at Ahmednagar was able to weave 30 yards of dungri in $8\frac{1}{2}$ hours, the warp and weft being of 10's counts and the number of picks per inch 28. This is equivalent to an average rate of picking of 60 per minute and is an extraordinarily good result. I have often watched the weavers at Salem and I find that they can easily do from 80 to 100 picks per minute whilst actually weaving, but their daily out-turn under favourable circumstances shows that at this rate of picking less than 25 per cent. of their time is spent in plying the shuttle and that the rest is frittered away. Weaving is a very monotonous occupation and the weaver is certainly unable to go on picking for any length of time without a change of some kind. The changing of pirns, the repair of broken threads, the shifting of the lease rods and other little incidents break the monotony of the work, but they greatly impair the efficiency of the loom.

I am convinced that, if the fly-shuttle hand-loom is to be largely used in making the finer classes of native goods, the direction in which improvement should be sought for is not so much in increasing the rate of picking which is already quite fast enough as in improving the details of the shedding and the working of the slay so that the operation of weaving sub-

* These facts are substantiated by the recently issued report of the weaving competition which took place at Calcutta at the exhibition associated with the Indian Industrial Conference of 1906. The Salvation Army loom, which was awarded the gold medal, was worked at the rate of 37.3 picks per minute for $7\frac{1}{2}$ hours, but at the end of that time the weaver showed signs of distress as did all the other competitors and it was, obvious that the result depended as much upon the endurance of the weaver as upon his skill or the merits of the loom.

jects the comparatively delicate threads to the minimum amount of strain. The idiosyncracies of the weaver however remain and I doubt if, under any circumstances, the average rate of picking throughout a day will ever rise to as much as 40 or 50 per cent. of what may be termed the normal rate at which picking can be done. Even in a weaving factory it is very difficult to collect reliable data regarding the working of looms and their output. The conditions vary so much from time to time and the human element plays so important a part that some exceptional motive must be brought into play to obtain anything like uniform conditions. For this reason I attach considerable importance to the results obtained in weaving competitions when a powerful stimulus is supplied to each weaver to do the best he can. Under the auspices of Local Associations in the Madras Presidency one or two such competitions have already been held and in February next a competition be held which is being organized on much more elaborate lines than any of those already mentioned. The main object of the competition is to ascertain the working capacity of the various hand-looms on the market under favourable conditions, but under as far as possible conditions which could be reproduced in a weaving factory. Each competition will last for six days and each weaver will have to work for 7 hours a day and the results will be judged by the week's outturn. In this way it is hoped we shall obtain reliable data regarding the output of the various types of loom when working on different kinds of cloth. A considerable number of competitions have been arranged for and the Government of Madras have contributed very largely to the prize fund, which it is hoped will induce the makers of every practical type of loom to enter them in the competitions.

Details of the cost of production.

* Turkey red yarn dyed with indigo.

From data collected at the Weaving Factory at Salem a tabular statement has been prepared giving details of the cost of production of several kinds of goods most largely manufactured there, and I would draw attention to the column in which the cost of each item is given as a percentage of the total cost. These figures are very interesting and it would be well if similar figures could be produced from other weaving establishments and the various items discussed. It will be seen that in the very fine cloths like angavastrams and turbans the cost of the raw material is but little more than a third of the cost of the finished articles, whilst in the goods made in the lower counts the percentage varies between 56 and 60. At Salem the warping and sizing is done outside the factory by men who do nothing else and they use fairly efficient warping mills and from the figures for warping and sizing it is obvious that there is not a great amount of room for improvement. The cost of the actual weaving work is probably the main item in which improvement can be effected and this is emphasized by the figures given regarding the rate of picking which varies from 12 to 23 picks per minute excluding country towels, the figures for which are not given as they are usually made on native looms with a simple fly-shuttle attachment. The item 'warping and sizing' varies considerably with different kinds of cloths and the figures given are probably lower than would be obtained in many other places owing to the fact that in Salem the preparation of warps is to a large extent a special business and is carried out in a much more efficient manner than I have seen elsewhere.

Whilst the experimental plant was in Madras a great many experiments were carried out in different methods of sizing and various forms of hand-warping mill were tried. The problem of preparing warps suitable

for use on native hand-looms was laid before the makers of warping machinery at home and after a great deal of discussion a plant was ordered from Messrs. Butterworth and Dickinson. It was set up and tried in Mr. Theagaraya Chetty's factory at Tondiarpet, but the results were anything but satisfactory and on account of other and more important work the experiments are at present in abeyance. The main idea was to employ hank-sizing and a sectional warping machine capable of turning out cheeses of warp of 500 ends. To make up a warp containing 3,000 or 4,000 ends the requisite number of cheeses were put on a spindle and the required warp run off on to the weaver's beam. The principal defect is in the sizing which proved inferior to that which is done by the native method where the warp is stretched out on a frame and carefully brushed. It is my intention as soon as possible to set up this warping mill again and prepare warp of unsized yarn and then to expose the warp in sheet form and size it according to the ordinary native method. I cannot say that I am very sanguine that this will be a success, but it seems worth trying and should effect a considerable economy in the cost of warping. Recently Messrs. Hattersley & Sons have brought out a hand slasher sizing machine, which will probably give good results with low counts where the hand-looms may be expected to turn out from 20 to 30 yards of cloth a day, but with the much finer class of goods which we are weaving at Salem, where the outturn is seldom more than 5 yards a day, the use of very long warps is not recommended as they remain in the loom much too long a time and the sizing deteriorates so much that the warps have to be re-sized on the loom and, when this is done, it greatly diminishes the outturn.

Before concluding this paper it may be of interest to

give some details regarding the factory itself. For the present the factory is located in a rather large straggling bungalow in the middle of the town of Salem for which we pay a rent of Rs. 60 a month. It was intended originally to instal about 100 looms, but owing to the difficulty of getting weavers nothing like that number has yet been reached and we find it difficult to keep more than about 35 looms in full work. The cost of running the factory last year was about Rs. 300 a month in addition to the sale-proceeds which amounted to about Rs. 350 a month. A steady improvement is however going on and with between 40 and 50 looms installed and an average of 35 at work the sale-proceeds now amount to over Rs. 1,000 a month and the cost of running the factory to about Rs. 200 a month. Ultimately it is hoped that the factory will pay its own expenses, in fact it could probably be made to do so now were commercial considerations of paramount importance.

To the capitalist who puts his money into a hand-weaving factory it is essential that a profit should be earned and as that is not done at Salem it may be well to indicate briefly why such a desirable result has not been attained. In the first place the factory is a Government institution, and it is generally recognised that commercial work cannot be carried on under Government with the same degree of economy as is possible when the control is vested in the hands of private individuals who are keenly interested in making it pay. In the factory we have arrived at some conclusions regarding looms which have already been stated, and if money-making was the object in view, we ought to at once discard all other types of loom and confine ourselves to those classes of work which pay best. New experiments are always being tried, looms are always being altered, the weavers have to accustom them-

selves to the new conditions, frequently a good deal of cloth is spoiled and generally the efficiency of the institution as a factory is greatly impaired. It is for these reasons that the factory does not pay and those who examine the accounts must take these facts into consideration. If some of the gentlemen who have interested themselves in hand-weaving and have started hand-weaving factories could be induced to furnish accurate manufacturing accounts, they would be of great value, but it is hardly fair to expect business men to give away the results of their experience and those who would like to find out whether the investment of money in hand-weaving factories is likely to be a success, must examine the published accounts of the Salem Weaving Factory in the light of my remarks.

III

THE FUTURE OF THE INDUSTRY

Of the industrial problems which India presents for solution, none are more complicated than those connected with hand-loom weaving. There are between two and three million hand-looms in the country producing fabrics ranging from coarse dungaree cloth, made from such loosely spun cotton that it cannot be woven in power-looms, to the magnificent kincobs and brocades of Benares and Surat. From abroad over 2,000 million yards of cloth are imported and 79,000 power-looms in the country manufacture nearly another 1,000 million yards. What the hand-loom weavers produce can only be roughly estimated from the known quantity of mill yarn consumed in the country. Probably it falls very short of the imports in quantity but considerably exceeds them in value. Thirty millions sterling or forty-five crores of rupees would

be a very moderate amount at which to value the outturn of the hand-looms of India. Whether these figures be accurate or not matters very little, as they are only adduced to indicate the order of magnitude of the interests involved in the indigenous weaving industry. They are certainly big enough to make the industry one worthy of careful study, and yet it will not be difficult to show that up to the present time very little of practical value has been done in this direction. That it has attracted attention, a great deal of attention, cannot be denied, but it has been mainly from amateurs or power-loom weavers. The former approached it from the artistic standpoint and deplored the decadence of the craft, the latter regarded it as an industry doomed to extinction almost as complete as that of hand-spinning. The former decried the investigations of those who thought that it had still a future as an industry and persisted in viewing every effort to improve the methods of the weaver as deliberate attempts to destroy those special features which raised it to the dignity of an art industry. The latter regarded it as impracticable to improve hand-weaving methods without eventually producing a power-loom weaver and refused to believe that it was possible to develop along lines which would preserve the characteristics of handwork.

Under these circumstances, it is not surprising that the administrators of this country have found some difficulty in deciding what measures would be appropriate to deal with the decadent condition into which the hand-weavers have fallen. Gradually, however, the opinion has gained ground that the situation is not absolutely hopeless and in almost every Province tentative steps have been taken to assist the hand-weavers, either by establishing experimental factories in which the problems of the trade could be studied, by opening weaving schools in which

improvements upon the indigenous methods of working are taught or by forming model Co-operative Guilds or Associations to assist the weavers in their constant struggle against adverse conditions consequent upon their poverty and lack of credit. In each of these ways something has been done, but only in what may be termed preliminary work as the practical effect on the industry and on the artizans is almost negligible.

It is unfortunate that those who have interested themselves in the solution of the Indian weaving problems have all been new to the trade at the outset and have acquired experience and knowledge by slow degrees and mainly by the process of trial and error. Possibly, by way of compensation, their outlook has been wider than would have been that of technically trained men and in their ignorance they have not been deterred by unseen and sometimes imaginary obstacles which would have kept back men of greater experience. The greatest achievement to their credit is unquestionably a restoration of confidence in the capacity of the hand-loom weaver to withstand the competition of the power-loom in extensive branches of the weaving business. There are brighter prospects in front of the ten millions of India who look to the hand-loom for at least the means of subsistence. The way to an amelioration of their condition has been discerned ; it remains to explore the path.

During more than a century, the power-loom and its various accessory appliances have been the subject of study by many ingenious mechanicians and they have devoted the whole of their skill to making it as perfect a machine as is conceivable and they have rendered it almost independent of the services of the weaver. It is true that it requires skill and experience to run it but it is of a different kind to that of the hand-loom weaver.

The hand-loom also received some attention and reached its highest developments about the time that it almost completely succumbed to its rival in progressive Western countries. The defeat, crushing and complete as it was, may be attributed in the main to economic forces. The products of the hand-loom differ essentially in character from those of the power-loom and the balance of advantages is probably slightly in its favour, but in temperate regions where the cost of living is high, the outturn of the hand-loom does not afford adequate remuneration to the weaver. He was reduced to poverty, destitution and finally driven out of the trade by the steady decrease in the cost of manufacture of power-loom fabrics. In the East, in India, the story is not quite the same and, though the hand-loom weaver has suffered, he has not been driven out of the field. To-day his looms convert about 400 millions pounds of yarn into fabrics of various kind and it is at least doubtful if in the palmiest days of the Moghuls or the East India Company such an enormous amount of yarn could have been produced by hand-spinning alone. He has not done perhaps much more than hold his own, but he has done it with the primitive appliances of his forefathers and without assistance from the Western mechanician.

This represents a very low stage of industrial efficiency, and who can doubt that the hand-weaver will be able to turn the tables on the power-loom weaver, if but a fraction of the capital, energy and organisation were devoted to his trade that have been expended in pushing power-loom weaving. The experimental factories have demonstrated this, and there are now, in the Madras Presidency at any rate, a number of small weaving companies able to keep going and apparently with prospects of better times in front for them. They have done little more than introduce the fly-shuttle loom and the rotary

warping mill, both great improvements on indigenous methods but almost certainly capable of further developments. Quite a number of methods of shuttle throwing have been patented during the last few years and some few of them have met with a greater measure of encouragement than their real merits warrant. The weaving competitions, which have become such a popular feature of the Industrial Exhibitions at the present time, have demonstrated over and over again that for simplicity, accuracy and speed of working nothing has yet been brought out superior to the best forms of the English fly-shuttle loom. Mr. D. C. Churchill has invented a loom full of promise, which automatically tends to correct one of the greatest defects of the hand-weaver, namely, the irregular rate at which he works. The weaver can ply his shuttle quite fast enough and nothing will be gained by further efforts to increase speed. The best prospect of improvement lies in the direction of gentler handling of the warps, the threads of which are frequently broken and the efficiency of the weaver will be increased if less time is wasted in mending them.

In the Salem Weaving Factory, we found that in an average day's work a weaver was seldom able to make more than twenty per cent. of the total number of picks he could easily make when steadily throwing the shuttle ; that is to say, four-fifths of his time was employed in operations other than actual weaving. It is for this reason that Mr. Churchill's spring control of the picking mechanism is likely to prove a new departure of great importance.

We may regard, then, with equanimity the prospects of ultimately obtaining what is wanted in the matter of hand-looms, but the preparation of the warp is still carried on in a very primitive way and though apparently capable

of improvement little or nothing has been done. The main reason for this is that it can only be carried out on a fairly large scale and must be associated with large groups of hand-loom. There is no difficulty whatever about arranging the warps ; the trouble comes when they are to be sized and the ordinary slasher sizing machine is not suitable. When in England last year, I consulted the textile experts at the Manchester Municipal School of Technology and I was furnished with introductions which enabled me to see at work a dressing machine which seemed to me would prove a solution of the difficulty. The warps prepared were of very high quality and equal to the best hand-dressed warps made out here. The work obviously required great skill and experience and a single machine was capable of dressing about a thousand yards a day. Probably on half this output, it would still be profitable to use it but that would mean that from 100 to 150 hand-loom would be required to draw their supply of warps from it. Experiments with such a machine must therefore be costly and can only be conducted in an organized hand-loom weaving factory. With Government assistance, it seems to me possible that the experiment will be made and though the loss will be rather heavy if it proves a failure, on the other hand, if it is a success, the future of hand-loom weaving will be assured.

One branch of weaving in India has not been subjected to European competition as solid bordered cloths have never yet been made on a power-loom. The weavers of these fabrics are fairly well off and if they have suffered at all, it is entirely due to changes in the fashions of dress. They are costly cloths and the solid borders are often woven with silk and gold lace in intricate patterns. The method of working these patterns is extremely simple but very laborious and it can be performed equally well and much

faster with a Jacquard machine. Experiments in this direction have already been started in the workshops attached to my office in Madras and any one interested in them will be welcome to see what has been done. The results are very satisfactory and indicate that the Jacquard machine will prove an extremely valuable addition to the border-loom or, in fact, to any type of native hand-loom engaged on moderately complex pattern weaving.

Those who regard weaving as an artistic handicraft, will probably deprecate the introduction of the Jacquard machine. Its effect on weaving as an art has been strongly criticised by Mr. Luther Hooper in a delightful book on "Hand-loom weaving" and I cannot refrain from quoting the concluding paragraph. "There can be no question that the best weaving was done before these innovations of the engineer and the mechanician were made. It would therefore seem, that the right road to improvement in weaving, as in all the crafts, can only be found by those who are willing to return to the traditional methods and simpler ideals of the earlier masters of craftsmanship." This summarizes a not inconsiderable school of thought and one that has much influence at the present day though utterly unable to stem the flowing tide. It is not modern methods but the abuse of modern methods they should rail at. According to Mr. Luther, "The Jacquard machine is responsible to a great extent, for the separation of the art of designing from the craft of weaving." Doubtless this is true in a sense, as the Jacquard machine facilitated the growth of the weaving factory which triumphed over the individual weaver through the economies effected by sub-division of labour.

It is a pity that the Indian craftsmen have not been studied by the master craftsmen of Europe who live in

modern luxury and pretend to despise it all. The lot of the Indian weaver is hard toil, often in the midst of extreme penury and "the pleasant ingenious occupation which exercises all his faculties," according to Mr. Luther, leaves him with the lowest standard of physique among all the artizan classes in this country.

THE greatest obstacle to the improvement of the condition of the hand-loom weavers is the artizans themselves. In a paper on the "Salem Weaving Factory" contributed to the Industrial Conference held at Surat in December 1907, I described the condition of the weavers, the nature of their work, the miserable existence which most of them lead and the hopeless attitude of mind, which renders them averse to any change. In the last twelve years, I have had a good deal to do with the artizans of the South of India and no class have I found more difficult to deal with than weavers. They are clever enough at their own work in their own way and are capable of turning out excellent material, but with an expenditure of time and labour that keeps them in a wretched poverty stricken condition.

There is an interesting chapter in Professor Chapman's work on "The Lancashire cotton industry" describing the condition into which the hand-weavers of England fell during the course of their prolonged struggle against the power-loom and I am tempted to quote from it to show that history is but repeating itself in India and that the economic development of the country has, under the operation of similar causes, produced similar results. He says: "The lot of the hand-loom weaver was[not an unpleasant one throughout most of the eighteenth century. Certainly, his food was simple, his clothing was coarse and he worked hard; but his life was not without variety, and it could be spent in the country and fresh air. Guest says of the weavers that they were a

fine body of men, full of the spirit of self-reliance. This he attributed to the fact that they sold their cloth and not their labour, that they were not servants but independent business men." That was before the advent of the power-loom, and during the interval between the introduction of machine spinning and the beginning of competition with power driven looms, the weavers enjoyed a transient period of extraordinary prosperity. Then came a time of adversity and the weavers gradually sank lower and lower in the social scale and finally disappeared altogether. In 1835 the evidence offered the Committee appointed to consider the condition of the hand-loom weavers represented the situation as appalling and Prof. Chapman quotes John Fielden as asserting "that a very great number of weavers are unable to provide for themselves and their families a sufficiency of food of the plainest and cheapest kind ; that they are clothed in rags, and indisposed on this account to go to any place of worship, or to send their children to the Sunday school that notwithstanding their want of food, clothing, furniture and bedding, they, for the most part, have full employment ; that their labour is excessive, not infrequently 16 hours a day."

Much of the distress to which the hand-weavers were subjected was due to their sullen, disdainful attitude. "Only the direst necessity could drive the typical hand-loom weaver into a steam factory, and not infrequently he preferred to fight famine at close quarters rather than surrender his liberty. . . . most hand-loom weavers competed with the factory, instead of entering it and attempting to secure for themselves as large a share as possible of the gain resulting from new economies in production. The handicraftsmen, as whole, at that time were entirely un-enterprising ; it is small wonder, therefore, that competition

cut prices at their expense. Their wages stood for the line of least resistance. The typical hand-loom weaver with his cottage loom, who dreaded the thought of factory life and remained rooted like a tree in his parish represented a social order that was already obsolete. . . . Partly as a result of the attitude of hand-loom weavers as a whole, the first steam weavers, both in England and Scotland, were nearly all women."

The resemblance between the fate of the English and the Indian hand-weavers is striking, but the analogy is not complete. The Indian hand-weaver, thanks to more genial surroundings, is able to keep going on a very little and has therefore survived and forms, and will undoubtedly continue to form, the largest section of the Indian industrial population. As an artizan, he is worse off than other artizans because he has been subjected to the stress of greater competition and the present generation have grown up under very adverse circumstances. The operatives in mills and factories earn much higher wages and are fairly certain of regular employment. They are independent and free, for there is competition for their labour, whilst the hand-loom weavers, though nominally working for themselves, are tied hand and food by their debts to the cloth merchants and moneylenders. Their intractableness and indolence is engendered by the feeling that they have nothing to lose, and they have sunk into such a state of apathy that they have no desire to rise. As long as they have sufficient to satisfy their animal cravings, they will not work and the long hours they have to work are forced upon them by the difficulty of procuring a bare subsistence with their inefficient methods of production.

There is little hope that anything can be done to alleviate the lot of those who have been allowed to grow

to maturity amid such surroundings and the best hope for the future of the weavers is to deal with their children. The hand-loom factories are extremely unpopular with adult weavers and those which are now running depend largely upon non-caste weavers trained in Mission and other schools. That any improvement can be effected by working along Co-operative lines is very doubtful and it is even still more certain that the individual weaver can never hope to better his present condition. The hand-loom weaving factory is the only direction in which progress seems possible. The weavers themselves are helpless and the organization and capital which are necessary to put the industry on a better footing must come from outside.

The warping mill and dressing machine are the key to the situation, the centre around which the factory must be built. The weavers need not necessarily all work in a single shed, their looms may still be in their own houses and they may still be allowed to work as they will, but instead of preparing their own warps, they will be supplied by the managers of the warping plant, who will finance the trade and place the finished goods on the market. Whether the weaver will be able to earn enough to keep his family under these conditions remains to be seen—if he cannot dispense with the assistance of his wife and family, there appears to be no reason, except that it has not been the custom, why the women should not ply the shuttle. The lighter kinds of weaving are admirably adapted for women and all over the world they are, or have been, so employed. In one Mission school in India I have seen a number of girls weaving with great success and there is no adequate reason why the custom should not spread. The simple life of an artizan's household leaves the women with ample leisure and weaving has much to recommend it as a domestic industry. Pirn winding might still be

done by children without interfering with their attendance at school, and it would give them that delicate sense of touch which is essential to those who have to handle cotton threads during the various stages of their conversion into fabrics.

The question of practical importance is how these changes are to be brought about ; how a new generation of weavers is to be created who will at any rate ply their trade on terms of equality with other artizans, who will be at least as well off as operatives in steam factories and mills. Education alone can do this and to be effective it must be begun at an early stage. To put my ideas in a concrete form ;—I should like to see some weaving schools started in the larger weaving centres, in which education and a training in weaving would be given to the children of weavers only. The boys should be received at about 10 or 12 years of age and should be bound as apprentices for at least 7 years. They should live at home and should be given sufficient wages to compensate their parents for the loss of their labour, but the working day should be spent in the school and they should be clothed and fed in the school. An elementary general education is necessary to counteract home influences and prepare the mind for the reception of new ideas. For the first half of the period of apprenticeship this should be the main work, the trade being considered of secondary importance, but during the last half of the period the reverse should be the case.

This proposal I know is contrary to the generally accepted principle that trades should not be taught in elementary schools or general education imparted in a trade school, but the principle is based upon a limited amount of experience gained in schools of this mixed character which were by no means efficiently managed. Year by year, it is

more and more strongly forced upon us that the modern conditions under which industrial work must be carried on involve the employment of a more intelligent and adaptable class of operative than has hitherto generally been deemed necessary. This is so in Europe and will be found to be equally so in India. To increase the efficiency of Indian labour is to solve at least one-half the economic problems confronting us. I therefore think it is essential we should educate the hand-weaver if only that he may be a centre of light and influence in his own community and contribute to dispelling the darkness and banishing the apathy which now enshrouds it. These schools will be costly, especially at first, but the industrial side should run as nearly as possible under factory conditions. From the educational point of view, it is the discipline of the factory that is necessary, and though there may be difficulty in disposing of the materials which must be used, it can doubtless be done by arrangement with those actually in the trade.

The education of the artizans is only one of the steps, though the most important, that should be taken if we are to restore hand-weaving to its natural place among Indian industries. Besides, provision for the training of the rank and file, adequate arrangements must be made for the education of those who will be the leaders in the trade, and the masters or managers of the future associated groups of weavers, be they in factories, guilds or associations. For them, a high grade technical school is required where the art may be studied in all its varied branches and where experimental work can be carried on. It has been decided to start such a school at Madura but the details of the scheme have yet to be worked out. The hand-weaver enjoys conspicuous advantages in the manufacture of art fabrics and we may hope that it will be found

possible to do something in this direction and preserve as far as possible the combination of artist and draftsman in one person. The organization of the hand-weaving of the future will include dyeing and finishing and, if it should prove possible to establish a dyeing and bleaching school also in Madura, there will be no great difficulty in combining it with the weaving school, and thus provide for the South of India a Textile Institute worthy of the great trade carried on and capable of rendering it invaluable assistance in future developments.

The power-loom has invaded almost every branch of weaving but not in every direction with the same degree of success. Where wages are high and the costs of living are in proportion, the hand-loom makes but a poor show, but where living is cheap, it has a better chance and for a wide range of fabrics can easily hold its own. The demarcation of the field in which hand-weaving may fairly expect to do well is a very important matter. There is much loose talk about the superiority of the one or the other method of manufacture which is based upon, at best, popular experience and is usually mere dogmatic expressions of opinions. Investigation is desirable so that hand-weaving factories may equip themselves for the outturn of those lines of goods in which they possess the greatest advantages over the power-loom. Concentration of effort along definite lines is essential and the mistake, so often made in the past, of trying to do too much will then be avoided.

CHAPTER IX

MISCELLANEOUS INDUSTRIES

WOOD DISTILLATION

I

Whatever be the outcome of the movement in favour of indigenous industrial enterprise, whether it results in the establishment of large organised factories or, as seems more probable in the immediate future, it leads to the development of numerous small centres of manufacture, it is certain that it will necessitate the installation of many plants to supply power in either large or small units. The power question is therefore an exceedingly important one and it may be of some interest to briefly state the situation in Madras in reference to the facts upon which it is desirable that attention should be concentrated. The fuels used in Madras are coal from Bengal and Singareni, wood from local forests and plantations and charcoal brought into Madras chiefly from the forests of Chingleput and North Arcot. Liquid fuel is also imported from Borneo by the Asiatic Petroleum Co., kerosine oil by several companies and anthracite coal and Bengal coke are used to a small extent in one or two suction gas producer plants.

The price of coal within the last few years has fluctuated between Rs. 12 and 16 a ton and, at the present time, it is somewhat easier than it was a year or two ago. For heating purposes one ton of Bengal coal

may be considered equal to $1\frac{1}{2}$ tons of really dry wood but the wood that usually comes into the market is green and, if it is stacked for a few months to dry, will easily lose 25 per cent. of its original weight, so that we may take one ton of coal as being equal to two tons of green wood. The consumption of wood in Madras amounts to about 120,000 tons a year and the price has been steadily rising for years past. The best kind of casuarina wood fetches Rs. 13 a ton and this is practically the same price as coal, although it possesses only half its heating value. In other parts of the Presidency, various kinds of jungle wood can be obtained at much lower rates and the railways, which consume large quantities, can usually make contracts at under Rs. 6 a ton. In regard to the price of coal, the principal factor is the cost of transport, whether by rail or sea. As the sources of supply of coal are all to the North of Madras railway freights are lower to towns situated in that direction, whilst they are higher to those lying to the South or West. Madras, Negapatam and Tuticorin are the only ports on the East Coast to which coal can be shipped with advantage. The cost of wood varies very much and obviously depends upon the proximity of jungles or plantations from which it can be obtained. From the fact that on many sections of the railways, wood is still used, notwithstanding the inconvenience entailed by its employment as fuel, it may be concluded that this material is distinctly cheaper than coal.

All over the world, wood is rising in value as the natural sources of supply become depleted and India is no exception to the general rule. If with the present prices of fuel, any large industrial development were possible, the increased demand would undoubtedly lead to enhancement of the rates. Around Madras, the supply of fuel is insufficient to meet the demand and the prices are steadily

rising, and, except in so far as they are kept-down by competition with coal, they will continue to rise. The price of casuarina wood is nearly double what it was twenty years ago and the profits derived from plantations are very considerable. But these tend to decrease owing to the increased rates for labour and the more extended area from which supplies are drawn. The area of reserved forests in the Madras Presidency extends to about 23,000 sq. miles and over the whole area the average annual increment is probably not more than half a ton per acre per annum. Assuming that figure, it would amount to more than seven millions tons equivalent to about half that quantity of coal. Most of this, however, is only available in the hill tracts, remote from the centres of population and industrial activity. The cost of transport renders it of little economic value and for not more than about half a millions tons a year can a market be found. On the West Coast there is a large area of forest in the hands of private individuals, but it is unlikely that any of this area could be counted upon to increase the fuel supply of the country, as much of it is capable of yielding good timber and for the rest the owners would demand too high a rate. On the East Coast, particularly in the districts of Chingleput and South Arcot, there are extensive privately owned plantations of casuarina, which is widely grown for fuel, but the high price which the wood fetches is evidence that the demand on them is greater than the supply and since the profits on existing plantations are high, it may be assumed that the area under casuarina will rapidly extend till the natural limit is reached.

On the Nilgiris, the Palnis and some of the high ranges, blue gum plantations of great extent could be started and would in few years yield very large supplies of firewood, as an annual increment of at least six

tons per acre is easily obtainable, but the cost of transport to places where the fuel would be of use is prohibitive. It would, nevertheless, be of advantage if these bare hill tops were clothed with vegetation and within reasonable limits it is certainly desirable that the small area planted out should be gradually extended. As reserves of fuel they might ultimately prove of great value but in the immediate future the justification for expenditure on them will have to be sought chiefly in the beneficent action which forests exercise in moderating the effects of wind, rain and other climatic influences.

Such being the existing state of things, and with no hope of any material improvement in the fuel supply of the Presidency, industrialism in the South of India must necessarily be of a restricted character. In metallurgical industries, a cheap supply of fuel is of vital importance and our inability to comply with this essential condition renders the vast iron ore deposits of Salem, Bellary, and other districts valueless. In electro-metallurgy and in electro-chemical industries a cheap supply of power, such as is obtained at Sivasamudram from the Cauvery falls, may prove to be a satisfactory substitute for cheap fuel, but the amount of such power in the South of India is very limited, and for the present may be neglected. Industries such as these are therefore out of the question and there are prospects of success only in those industries in which the fuel used, whether for power or heat, forms only a small part of the total manufacturing expenses. A local supply of raw material, a local demand for the goods and in some cases a local supply of suitable labour, are all factors which may more than counterbalance the disadvantages due to the high cost of fuel. Again some special condition such as the fragility or bulkiness of the articles produced may operate in favour of a local industry which otherwise

would be hopelessly handicapped by expensive fuel. The manufacture of glass, for instance, has been started in Madras and may become an established industry in spite of dear fuel and an unfavourable climate, because it is protected by high freights and heavy packing charges relative to the value of the imported articles. The most important element upon which success depends seems to be in this case the existence of a sufficiently large local market for the outturn of the factory. Lastly for such work as pumping water, power is required and though the cost of the fuel is the main item in the cost of the work, the extent to which this operation will be affected by the price of the fuel depends upon the value of the water. It is easily possible to conceive that the water, whether for town supply or irrigation, is so valuable that all that is available will be made use of, and the field for employment of engines and pumps will not be increased or diminished by fluctuations in the cost of fuel.

The calorific power of fuel is not the sole factor which is taken into account in assessing its value. For domestic purposes, as we have seen, wood is nearly equal in price to coal, although it yields but little more than half the amount of heat. Similarly from wood large quantities of charcoal are prepared although in the process of conversion about one half the total heat producing power is dissipated. The charcoal is valued for the intense heat which can be developed by its combustion, for its freedom from impurities and for the absence of smoke attending its use. But in the processes now employed about five tons of wood are required to produce a ton of charcoal. It is therefore an expensive fuel and only used when its special properties are in demand. In recent years, it has come largely into use for the manufacture of gas for generating power in gas engines. The

initial expense of the fuel is counterbalanced by the efficiency with which power can be obtained from the gas it yields.

The fuels available for generating power in this Presidency have already been mentioned, and we have seen that the price of each fuel fluctuates from time to time and varies enormously in different places owing to cost of carriage from the sources of supply. The size of the generating unit also materially affects the question as to which is the cheapest fuel to use, and in nearly every case, it is a matter of some difficulty and requires extensive practical experience and intimate knowledge of local conditions to satisfactorily decide what fuel should be used and what method of using it should be adopted. The Diesel engine is by far the most efficient heat motor that so far has been designed, but whether it can compete with steam engines using coal or gas engines supplied with gas from one or other of the various types of gas producers, in which coal, coke, charcoal, wood or waste products such as saw dust or tannery refuse are burned, depends on the relative prices at which these sources of heat can be obtained. In most towns, for very large units, the steam engine still holds its own, of which evidence is afforded by the fact that during the last few years several large cotton mill engines have been installed in this Presidency and in only one instance has a Diesel engine been employed. On the other hand for smaller units, but still comparatively large ones, the steam engine shares the field with the Diesel engine, whilst for small sources of power, gas and oil engines alone can compete, and at the extreme end of the scale, the oil engine enjoys unrivalled supremacy. To the people of Southern India, the interest mainly lies in the relative advantages of oil and gas engines. Where large amounts of power are consumed there are always competent Engineers availa-

ble to decide how it is to be obtained, but the projectors of small factories and agriculturists or land owners, who want to pump water, cannot easily obtain such expert advice, and it is an unfortunate fact that they are prone to decide a question like this on the advice of incompetent or interested parties and generally with dire results. Government fully recognise this fact and though the Department of Industries has ceased to exist, this branch of its work is still carried on and for a trifling fee, the whole experience of the late Department is placed at the disposal of those who wish to make use of it.

The liquid fuel or kerosine oil used in oil engines is imported from abroad and is cheaper in Madras than anywhere else in the Presidency. There is competition in the kerosine oil trade but the liquid fuel is monopolised by one company, and it has power to withhold supplies or arbitrarily change the price at any time. This is not an altogether satisfactory position and it is at least politic to encourage any rival system that can compete with oil engines using liquid fuel. For gas engines, charcoal is the most convenient material from which the gas can be obtained and it is naturally cheapest where wood is most plentiful and when there is no large demand for it for other purposes. This is generally in the neighbourhood of the forest tracts and remote from railways. These are nor usually centres of industry and in order that the field for employment of gas plants may be greatly widened, it is necessary that there should be greater inducements to manufacture charcoal and that more economical methods should be employed than those now in vogue. It is certainly a point in favour of the gas engine that its fuel can be obtained in the country and need not be imported from abroad and it is therefore a matter of some economic importance to encourage the development of charcoal manufacture on improved lines.

Four years ago, the attention of Government was first directed to the probability of a growing demand for charcoal and an enquiry was started to ascertain what prospects the scientific method of preparing charcoal known as wood distillation offered for the employment of capital to those interested in the improvement of Indian industries. The information finally collected was placed before an Advisory Board appointed by Government to consider whether the industry should be left to private enterprise or undertaken by Government. The Advisory Board reported that it did not offer sufficient inducements for the investment of private capital and thought that if it was desirable to start the industry, it should in the first place be undertaken by Government. The orders of the Secretary of State in regard to the pioneering of new industries preclude the possibility of this being done and things must remain *in statu quo ante* unless it can be shown that the opinion of the Advisory Committee was not well founded.

II

A careful reconsideration of the facts gathered more than two years ago, supplemented by information of considerable value obtained whilst in Europe on furlough, induces me to put forward a case for wood distillation as an industry eminently suited to Indian conditions at the present time. It is not a difficult or complicated industry. It can be started with a moderate capital outlay, the raw material is available in sufficient quantity to secure the permanence of the industry and for the products there is an assured market at remunerative prices. It is true that it is a new industry to the country, and that no one here has any practical experience in working it, but it is carried

out on a large scale in many other parts of the world and there will be no difficulty in obtaining the services of an expert to start the plant and train local men to run it.

The methods of burning charcoal prevalent in India are practically the same as those pursued in other parts of the world where this primitive process has not been displaced by wood distillation. Briefly, the wood is stacked in large heaps, protected from the atmosphere by a covering of earth, and fired with a limited amount of air. The heat generated by the combustion of part of the wood causes chemical disintegration of the rest, with the evolution of the acid vapours and tar and there finally remains a residue consisting of almost pure carbon. The one product is carbon or charcoal of which about two tons are obtained from every 10 tons of wood carbonised. This process is very simple, but extremely wasteful, as by it, from hundreds of thousands of tons of good wood, we every year obtain none of the valuable bye-products which a more scientific procedure would render available. In place of this crude way of treating wood when charcoal is required, it may be subjected to prolonged heating in closed retorts or kilns, whereby all the volatile matter is driven off and a residue of practically pure carbon left behind. The volatile matter is of complex composition and yields on condensation pyrolytic acid and tar. The liquor is allowed to stand in tanks whereby the tar sinks to the bottom and the supernatant liquor is then distilled, yielding crude wood spirit and acetic acid. This distillate after standing in wooden tubs for a certain time, whereby further separation of impurities is effected, is mixed with milk of lime and transferred to a copper still and again subjected to heat till all the wood spirit is removed. The residue consists of an aqueous solution of acetate of lime, which is concentrated and

finally dried to a grey powder in a kiln. The wood spirit is subjected to fractional distillation and commercial methyl alcohol produced. From the destructive distillation of wood, we therefore obtain four marketable products :—

- (1) Charcoal.
- (2) Acetate of lime.
- (3) Methyl Alcohol.
- (4) Wood tar.

There is also a large quantity of incondensable gas which passes through the first condensation process, and can be utilised to assist in heating the retorts. All these products are of considerable commercial value.

The price of charcoal in Madras at the present time is Rs. 30 a ton. The acetate of lime fetches from £ 8 to £ 11 a ton in the London market and may be taken as worth fully Rs. 120 a ton in Madras. The methyl alcohol fetches from 2s. to 2/6 a gallon in London and may be taken as worth Re. 1 per gallon in Madras, if it is to be exported from the country. As will be subsequently shown, a market can be found for it in India in which case it will be worth at least Rs. 1-8-0 a gallon at the factory. There remains the tar which is worth a great deal more in India than in England. Last year, 1909-10, there was imported into Madras 23,861 cwts. of tar valued at Rs. 79,030 or slightly over Rs. 66 a ton. It will therefore be well within the mark to assume that the locally manufactured tar will be worth Rs. 40 a ton at the factory. Experiments have been made in England with a considerable number of Indian timbers to ascertain what they would yield on being subjected to destructive distillation. In the case of blue gums which grow so freely on the Nilgiris and of casuarina, ten ton lots were sent home and the experiments were on a sufficiently large scale

to yield fairly accurate commercial results. These are presented in the following table.

	Blue gum.	Casuarina wood.
Charcoal, per cent. ...	35	30
Acetate of lime, per cent.	5·42	5·2
Methyl Alcohol,		
gallons per ton,	3	4
Tar, per cent	5½	4½

From 10 tons of casuarina wood, we should therefore obtain products worth Rs. 228 as shown in detail in the following statement :—

	Rs.
Charcoal, 3 tons at Rs. 25 per ton	... 75
Methyl alcohol, 40 gallons at Rs. 1/8 per gal.	60
Grey Acetate of lime (80 %) 12½ cwt. at	
Rs. 120 per ton	... 75
Wood tar 9 cwt. at Rs. 40 per ton	... 18
	—
Total ... 228	—

It now becomes possible to present a balance sheet to show the probable results, which would be obtained, if a wood distillation factory were started on the East Coast, in the neighbourhood of large casuarina plantations, preferably situated near the Buckingham Canal, so that advantage may be taken of water carriage to reduce the cost of transport of raw material as much as possible. To deal with about 6,000 tons of dry wood per annum, such a factory would cost, erected in complete working order, about Rs. 1,50,000 and a company with a paid up capital of Rs. 2,00,000 would have ample funds to carry on the business. The principal items on the debit side of the balance sheet would be the cost of the wood and the cost of the fuel for working the furnaces and

the stills. It would of course be possible to use part of the wood this way, but it will be found more economical to buy coal. For the casuarina wood I have allowed Rs. 8 a ton and for the coal Rs. 13 a ton delivered at the factory. 10 per cent. depreciation is allowed on the whole plant and the other items are based on the actual charges incurred on a wood distillation plant of about this size in Germany. The total amounts to Rs. 1,00,900 per annum as shown in the following statement :—

				Rs.
Wood, 6,000 tons	...	...	...	48,000
Coal, 1,000 „	...	...	...	13,000
Lime, 150 „	...	...	...	900
Labour	...	...	...	5,000
Repairs	...	...	...	4,000
Management	...	...	...	15,000
Depreciation	...	...	..	15,000
				<hr/>
				Total Rs. ... 100,900
				<hr/>

We have already seen that 10 tons of casuarina wood will yield products worth Rs. 228. 6,000 tons will therefore yield products worth Rs. 136,800 and the gross profit on a capital of Rs. 2,00,000 will amount to Rs. 35,900 per annum. I think that there can be no doubt that away from the immediate neighbourhood of Madras, casuarina wood in abundance can be obtained at lower rates than those quoted and if this be so, the prospects of the undertaking are still more favourable.

It may be interesting to compare the conditions, under which this factory will work, with those which I actually found in a factory at Ivry near Paris. The wood cost Rs. 13 per ton and 4 tons were required to produce a ton of charcoal. The charcoal was sold at Rs. 45 a ton, that is

to say, wood worth Rs. 52 produced charcoal worth only Rs. 45, and the whole of the working expenses and the profit on the manufacture, together with the loss of Rs. 7 on each ton of charcoal produced, had to be realised from the sale of the bye-products. The firm found it more profitable to work them up into marketable chemicals and the acetate of lime was converted into white or brown sugar lead, glacial acetic acid and acetate of copper, and in the export department, I saw a large consignment of acetate of lead packed for shipment to Bombay. For the tar, there was no market and it was found that the best way of disposing of it was to burn it under the stills. The methyl alcohol was rectified to a high degree of purity and sold to colour works or for the manufacture of formalin. The firm at the time of my visit were also experimenting with a direct process for the manufacture of acetone, another very valuable product from pyroligneous acid. Dealing with such a friable material as charcoal, there is always a large amount of waste and this is utilised for the manufacture of what is known in France as *charbon de Paris* and *Bouches de Noailles*, which are practically charcoal briquettes. The charbon de Paris is made as follows :—

75 lbs. of powdered charcoal and 35 lbs. of tar, which may be either coal or wood tar, and half a pound of carbonate of soda are mixed under edge runners and the resulting product compressed in moulds to briquettes of various sizes and shapes. The briquettes are allowed to dry from 6 to 8 days and are then packed in closed kilns and fired internally with a very limited supply of air. In the course of about 12 hours, nearly all the tar is removed and the comparatively soft briquettes are converted into hard blocks of carbon somewhat similar in appearance to coke. For these, there is a very large

demand in Paris for domestic and other purposes in which a very slow rate of combustion, freedom from smoke, smell and noxious fumes are essential. They consequently sell at a high price, the rate at the time being as much as Rs. 100 per ton. With our cheaper raw material, we could manufacture them at probably half this price, and as there is no doubt whatever that they would be extremely well adapted to Indian domestic conditions, it is possible, therefore that a large market might be found for them. At any rate, the experiment is very well worth trying as it could be conducted on a small scale at very little expense. In Paris, it is found profitable to complete the manufacture of the products of wood distillation and I think it will be advisable to proceed on the same course in India. The Government Cordite Factory at Aruvankad on the Nilgiris might purchase large quantities of acetate of lime to manufacture it into acetone, but otherwise there is not likely to be any demand for acetate of lime except on the part of chemical manufacturers to convert it into more useful products such as sugar of lead which is used in dyeing and calico printing, for the preparation of alum mordants and for the manufacture of chrome yellow. It would certainly not be feasible to manufacture acetone in the plains of India as the boiling point of this compound is very low and it is highly volatile and difficult to pack in such a way that it can be transported without loss.

Wood spirit is largely used in Europe for denaturizing alcohol, but for this purpose, as caoutchoucine is used in India, it is hardly likely that the advent of a wood distillation plant would lead to any change. The use for the wood spirit must be found in the manufacture of formalin compounds and in the sale of rectified spirit suitable for varnish making.

For the tar, there already exists a local market which is at present met by importation from abroad and it will probably be convenient to simply displace part of the imports, but if necessary, the tar can be worked into products such as creasote and guaiacol, both disinfectants which would find a ready sale in this country.

The above represents a fair statement of the prospects of a wood distillation industry and they seem to me to be sufficiently attractive. Once started on the moderate scale now proposed it would be easy to extend them if my anticipations are realized. On the Nilgiris, in the Salem District, in North Coimbatore and in North Malabar, wood could probably be obtained at even lower rates than those charged for casuarina in this note and there would be little risk in setting up additional plants with the experience available if these proposals are successfully carried out.

MILK PRODUCTS

In strange contrast with Burma where milk is scarcely ever used as an article of food, in India it plays a very important part in the dietary of the people all over the country. A rough estimate of the cows and she-buffaloes places the number at about 40 millions, and it is well-known to all interested in the matter that the average yield of milk is extremely poor and probably does not amount to more than a quart per head per day. In various parts of the country there are to be found special breeds of cattle which yield much better results than this. During the last 20 years Dairy Farming has been a subject of investigation by specialists with very valuable results. As long ago as 1895 Mr. Mollison, the late Director-General of Agriculture, who was then the Superintendent of Government Farms in Bombay wrote:—"The yield of Indian cows rarely ex-

ceeds 20 to 25 lbs. per day. 12 to 16 lbs. more nearly however approximate the average of good cows in full profit. Buffaloes on an average give considerably more than cows in India and their milk is also much richer. Under skilful management there is no reason why the milk breeds of India should not be very much improved. It is quite within the bounds of possibility to breed up Indian buffaloes to become one of the best butter producing breeds in the world." This prediction has to some extent been realised in the Government Dairy Farms in the United Provinces and Meagher and Vaughan in their book on "Dairy Farming in India" published in 1904 give the results of observations made by them on well bred milch cattle at the Allahabad farm. There the Hansi cows yielded from 3 to 4 gallons of milk per day and buffaloes of the Murrah breed from 4 to as much as 6 gallons per day. Cattle can be obtained which will yield from 4 to 7 gallons of milk during the milking season, and as the period between two successive births averages about 500 days we may assume that it is possible to obtain a yield on an average of a gallon of milk per day from a herd of cows during the whole of their useful life.

It may be taken as fairly certain that owing to the rapid growth of the population, the milk supply in India is insufficient for the needs of the people and evidence of this is to be found in the rapid advance in the price at which milk is sold in large towns. Especially so has this been the case in the past year or two, during which in addition to the increased demand, there has been a material rise in the cost of cattle food. Further evidence in this direction is to be found in the imports of condensed milk which have increased by more than 50 per cent. in the last five years. From the Trade Returns for 1909-1910,

I find that 9,198,428 lbs. of condensed milk were imported into India and Burma valued at Rs. 25,61,722. Of this Burma took the greater part, its share being not less than 56 per cent. of the whole imports, whilst that of Bengal was 22½ per cent. and that of Madras nearly 13 per cent.

If we assume that the milk supply of India amounts to only 5,000,000 gallons per day, which would mean that each cow only yielded one pint of milk per day and that its average value is now 8 annas per gallon, we arrive at the somewhat startling result that the total value of the milk produced in India is not less than 90 crores of rupees per annum. Compared with this gigantic sum, it may at first sight seem trifling that milk to the value of rather more than a quarter of crore of rupees is annually imported. But looked at from another point of view, it is a sign of the times and may be taken as an indication of the ease with which enterprising foreigners can find a market for their surplus products in this country. Here, it is evident that there is an enormous field for improvement, and I think there is no doubt that if sufficient attention were paid to the matter of breeding milch cattle, the yield throughout India could be increased by at least 50 per cent and possibly doubled. In other countries, results at least equal to this have been achieved and I need only mention the extraordinary success of co-operative dairying in such widely different countries as Denmark and Ireland.

Not only does India import tinned milk to the quantities already mentioned, but there has always been a large importation of ghee along the Northern frontiers the average value of which is about Rs. 50 lakhs per annum.

With an agricultural population fully alive to the value of their milch cattle and working their products into

a marketable form on a co-operative basis, India would not only be able to supply her own requirements but might easily become one of the largest, if not the largest, exporter of dairy produce in the world. I am fully aware that it is hopeless to expect any rapid improvement in this direction but that is no reason why attention should not be drawn to the matter, especially in view of the fact, that recent developments in the methods of dealing with milk render it possible to preserve it for an indefinitely long time in an extremely concentrated form. Condensed milks have long been known and are largely used, but it is generally recognised that even the best of them are inferior to fresh milk and are only largely used because of the facility with which they can be transported.

In recent years, various processes have been introduced for converting liquid milk into a dry powder, but the majority of these have not met with any great measure of success, chiefly because the temperatures to which the milk is subjected during the process of drying are so high that the physical constituents of the milk itself are partially changed and the resulting powder when again mixed with water yields a fluid with solid particles suspended in it which differs very materially from fresh milk.

Whilst at home last year, I came across a new process of converting milk into a dry powder which seemed to be worthy of further investigation. I was able to interest the patentees of the process in the Indian milk question and they were good enough to afford me ample opportunity to investigate their method of working in every detail. Their principal factory is situated in Cheshire and the plant, which they have erected there, is capable of dealing with about 5,000 gallons of milk per day, but at the time of my visit, they were only able to get delivery of about 3,000 gallons per

day. I am not at liberty to give a very minute description of the process employed as its successful operation depends upon attention to many details which naturally a commercial concern does not wish to have disclosed. At the time of my visit to the factory, which was in the early morning, the farmer's carts were bringing in the morning milk supply. The milk was first weighed and then warmed and sent through a cream separator whereby about 7 per cent. of commercial cream was extracted. This was stored away in a cool room and daily sent to London. The skimmed milk, after leaving the centrifugal separator, was pumped into a pasteurizing kettle and then passed into a vacuum pan where under a vacuum of 26" to 27" it was concentrated to 2/9 of its original volume. The final process whereby this highly concentrated liquid milk was converted into a dry powder was extremely simple, but its successful operation was the result of much experimental work, into the details of which I am precluded from entering. Briefly, it consists in pumping the milk through an extremely fine hole in a plate at the end of a nozzle which projects into a wooden chamber lined with tin plate, into which a current of filtered hot air was blown. The pressure of the milk behind the spray plate varied from 3 to 4 thousand lbs per sq. inch, and in the chamber the milk was sprayed into a fine mist and almost instantaneously deprived of its moisture, falling to the bottom of the chamber as an impalpable white powder. In the rear of the chamber suitable filters were provided through which the hot moist air escaped to the outside leaving all the milk powder behind. Extreme care has to be taken in filtering the very large volume of air which passes through the chamber and its temperature is maintained at 175 to 180° F. by regulating the

quantity of concentrated milk which is sent in to be evaporated.

This drying process could be equally well applied to unconcentrated milk but the output would be very much smaller and the cost of evaporation much greater. On the day of my visit the milk powder being made, as has already been mentioned, was from milk deprived of the greater part of its cream, but the same process is equally applicable to unseparated milk and large quantities of what is known as full cream milk powder are so manufactured. The yield of milk powder from skimmed milk is about 8 per cent. of the original weight and from unseparated milk about 12 per cent. and the plant, I saw at work, was capable of producing about $2\frac{1}{2}$ tons of normal milk powder or 35 cwt. of skimmed milk powder, per day. It is interesting to note that wheyed milk powder the principal constituent of which is milk sugar, can also be produced in an exactly similar manner and in fact is so manufactured, either for sale as such, or for mixture with the other milk powders so as to produce milk foods specially suited for infantile or impaired digestions.

This method of producing dry milk powder is equally applicable to eggs, and the egg powder so produced can be used for every purpose for which fresh eggs are employed in cooking. The eggs delivered at the factory first have their outer shells thoroughly washed in clean water and are then thrown into a centrifugal which entirely separates the fluid contents from the outer shell. The liquid which is a mixture of the yolk and the white of the eggs is pumped directly into the hot air chamber and converted at once into a dry powder. The treatment of eggs demonstrates more clearly than is possible with milk the important advantage of this process, and that is, that the albumen which forms the white of the eggs and which is present in

milk only in small quantities is not coagulated by the temperatures to which it is subjected in the drying chamber. At this Cheshire Factory egg powder was only occasionally produced, as in England, the demand for fresh eggs is so great that they command a much higher price than that at which it would be profitable to convert them into egg powder. In India this would not be the case, and it seems to me that it would be quite possible to produce eggs by scientific poultry farming on a co-operative basis on a sufficiently extensive scale and at prices which would make it profitable to manufacture egg powder for export.

Poultry rearing in India has never been developed to anything like the extent that is possible, owing to the fact that eggs, as an article of food, are much too expensive for the bulk of the population. Assuming however a demand for fresh eggs in large quantities at a fixed price, it seems to me not improbable that the villagers could be induced to take to rearing poultry as a subsidiary occupation, and that as such it would be a considerable source of additional income. A plant for drying eggs is a comparatively simple affair compared with that which is necessary for producing milk powder, and the capital outlay involved need not be large, so that the only difficulty which I can see in starting such an industry in this country would be to secure a sufficiently large supply of eggs at the outset. Probably it would be necessary to start a large poultry farm to begin with and, to offer to supply fowls with a good laying strain, to the surrounding villagers, buying such eggs as they produced. I do not know if any records of egg laying have ever been maintained in India, but great importance is attached to them by the Agricultural Department in Ireland and in a recent number of the Department's journal there are some interesting records given. It ap-

pears that the general average is rather more than 111 eggs per bird per year. Whether it is greater or less than this in India I have been unable to ascertain, but assuming that fowls can be obtained which will lay 9 dozens eggs in a year, if these eggs fetch 3 annas a dozen, each hen will produce an income of Rs. 1-11-0 per annum. Whether this would be profitable or not would depend upon the cost of keeping the hens. In Ireland, it amounts from Rs. 2-8-0 to Rs. 3 per annum, but in India it should be materially less than this, as, if the hen population be not too dense, they will be able to pick up the greater part of their food themselves.

With samples of the different products of this English factory, I have made a number of experiments both in England and in India with eminently satisfactory results. The flavour of the milk is slightly different from that of fresh milk and would probably be preferred by most people to that of boiled milk. Compared with condensed milks, the milk powders possess many advantages. In the first place, they are somewhat cheaper, and, as they contain no moisture or added sugar, are much less bulky. After the tin is opened its contents can be used up gradually, and here in Madras, at any rate during the cold weather, the milk powder will keep in good condition for several months. It is essential of course that the powder should be kept perfectly dry. From a hygienic point of view, the milk is perfectly safe and the scrupulous state of cleanliness maintained in the factory, which is essential for the working of the process, is a guarantee of the purity of the products.

Before the milk powder can be used it has to be mixed with water, and it is of course necessary that the water should be safe. This involves a little trouble and is probably the principal disadvantage in using milk powder as

compared with condensed milk. Buffalo milk which contains nearly twice as much fatty matter as cow's milk seems to be well suited for treatment by this process. To start with the percentage of fat can be reduced to any extent desirable by the use of centrifugal separators and the milk so modified converted into powder. The separated fat may be made into butter or ghee, and where there is a large demand for either of these commodities, the whole of the fat can be removed and the milk powder made from the separated milk will then be an excellent material for the manufacture of what is known in Northern India as Dahi and in Madras as Moru.

For invalids and young children, normal milk is not an altogether satisfactory food and it is often necessary to modify it in some way. On a large scale this can be done by mixing the dry powders resulting from the milk which has been treated so as to secure a predominance of one or other of its constituents. For young children, for instance, it is a simple matter to prepare a mixture of ordinary milk and wheyed milk which will have a composition almost the same as human milk, and for invalids, from the wheyed milk powder, a solution can be prepared of much greater strength than that which can be obtained by the ordinary method of preparing wheyed milk. Under certain circumstances, this may be a great advantage as an invalid can obtain a large amount of nourishment from a comparatively small volume of liquid.

THE ART INDUSTRIES OF SOUTH INDIA

Craftsmanship reached a high degree of excellence in the South of India when the country was under its Native rulers and there are extant many beautiful specimens of old work. The artizans lived under the patronage

of the Rajahs and Zamindars and devoted their skill and experience to enhancing the fame and prestige of their masters by contributing to the magnificence of their surroundings. The stonemason, the sculptor and the wood carver constructed and embellished the palaces in which they lived and the temples in which they worshipped; the weavers and the jewellers furnished clothing and ornaments for the adornment of their persons; and the metal-workers supplied the household vessels and domestic utensils, but the highest development of their work found expression in the design and decoration, of the trappings and vehicles used in State and religious processions. In the former elephants played an important part, and the howdahs were often sheathed in silver and in part plated with gold, the trappings were of silk supported by a coarser fabric underneath, and the Mahout carried a goad, always of elaborate design and frequently of exquisitely carved steel. In the religious processions the gods were removed from the temples and carried round the precincts of the sacred edifice in vahanams, which were special carriages in the form of some animal more or less mythological and conventional. The frame work was usually constructed of wood and covered with silver plates very highly worked in repoussé.

In ancient times the south of India, and more especially Mysore, was celebrated for the quality of the iron and steel which was there manufactured, and the arts of the armourer and smith reached a high degree of perfection. The *wootz* steel was held in high esteem for weapons and was certainly greatly in demand throughout the East and it is not improbable that the celebrated blades of Damascus were forged from it.

Under British rule the indigenous art industries have to some extent decayed. The picturesque pageantry of

the native courts has disappeared and the descendants of the old chieftains and princes adorn their reception rooms with gilt mirrors, glass chandeliers and Parisian ormolu and bronzes. Musical boxes, mechanical toys and the phonograph excite their wonder and amuse their idle hours. The gilt and tinsel of Europe attract them more than the artistic productions of their own countrymen.

Accustomed to work for a patron under the old régime, and shielded more or less from the effects of competition, the hereditary art workers have fallen upon evil days and to earn a livelihood have been forced to meet the demands of the dealers and globe trotters for cheap imitations of what they were formerly encouraged to produce and which they are still capable of making if they are allowed to work under conditions which suit their artistic temperaments. Though much harm has been done there are still many talented and honest craftsmen who, if given the opportunity, can do good work, and in recent years there has been an unquestioned revival in the handicrafts of the Madras Presidency. For this the Nattukottai Chetties are largely responsible. As is well known they have provided very large sums of money for the restoration of the great temples in the south and on this work many skilled artizans have been employed for a long period, and there is but little doubt that the modern restorations are quite equal in merit to the original structures. There is plenty of evidence that the old skill can still be called forth by congenial surroundings and there is not the least doubt that the craftsmen of to-day, are in no way inferior to their predecessors, but when employed to work against time for a foreign market, and for patrons with whom they have no sympathy, they fall away horribly in their efforts to produce what they think will please.

Even in the Native States where the conditions of life have changed less than in British India the demand for the services of the local art craftsmen is not what it used to be owing to the general prevalence of the idea that it is a mark of enlightenment to prefer Western methods of decoration. The fault of course lies partly with the craftsmen themselves, who, through conservatism and possibly also lack of opportunities, have failed to adapt themselves and their crafts to the changed conditions of the present day. This is very strongly exemplified in the new palace at Mysore, the internal decoration of which is almost entirely the work of the subjects of that State. Even though the general effect produced by the lavish use of indigenous ornaments is not beyond criticism, yet there is not the slightest doubt that the determination of those responsible for the building of this new palace, to have the work carried out by the craftsmen of the State has done much to place the art industries of Mysore on a new footing and give them a new lease of life. There is much truth in the contention which has been put forward that the decadence of Indian art industries is due to the neglect of Indian architecture and to the adoption of purely utilitarian ideas, in regard to both public and private buildings, since the former were placed under the Public Works Department. There is of course another side to the question which cannot now be discussed, but under an administrative system the key-note of which is efficiency, it is obvious that utilitarian rather than artistic considerations must be predominant. Nevertheless, the effects of the present policy have produced many misgivings in the minds of those responsible for the administration of this country, and in none perhaps more than Lord Curzon, who during his term of office did much to restore the prestige of Indian art, and if his effort

did not meet with the success they deserved, it was largely due to the deep-seated nature of the evil he sought to remedy.

In recent years the true functions of art schools in India have been recognised and they are now doing much good work, but the remedy is not entirely in their hands, as though they may train an art craftsman or an artist, they cannot find him opportunities of pursuing his art or craft afterwards. In Madras, to a greater degree than anywhere else, this has been recognised and the Council of the Victoria Technical Institute are making a real effort to place the skilled artizans in this Presidency in touch with those who can appreciate and desire to possess good specimens of the various Arts and Crafts still carried on. The Victoria Memorial Hall, in the Pantheon Road, has been built and, by purchase from the artizans, has been filled with specimens of the best work they are capable of turning out. All the articles are for sale and when sold are replaced by others and thus a constant flow of orders pass to the workers. The Institute, in fact, plays the part of a patron and secures for the workers a succession of opportunities for displaying their craftsmanship and ingenuity. The scheme is still in its initial stages and those who are behind the scenes are fully aware of the difficulties which lie before them. It is to them a matter of great regret that they are almost entirely dependent upon Europeans for patronage and that the wealthier classes in this country take little or no interest in this truly Swadeshi movement to infuse life and vitality into the Arts and Crafts of the Presidency. It is becoming increasingly evident that but a minor degree of success can attend their efforts so long as the people themselves hold aloof. A national Art is one of the clearest indications of a vigorous national existence and those who

are able to read the signs of the times suggest that the political aspirations of India are much on a par with her artistic perceptions.

Except weaving, the art industries of Southern India are purely Dravidian and have been but little influenced by the long period of Moghul domination over the rest of the country. The hard gneisses, which crop up every where, formed the principal building material and the forms which this could be made most readily to assume have deeply influenced the craftsmen who later on learned to work in wood and metal. At a very early date steel tools of excellent quality must have been made, or the masons and stonecarvers could never have attained the skill in rendering such an intractable material the medium for the expression of their ideas which even the most ancient remains display. A regular system of architecture was evolved, divided into orders, each of which was governed by rules and sub-divided elaborately into proportional parts to control the master builders and the rigidity with which these formulae were observed is clearly visible in all the temples, chutrams and ancient buildings which still exist. Wood never entered very largely into Dravidian architecture and was probably only employed for doors and for verandah pillars in domestic buildings. The durable South Indian timbers are all very hard and the carpenter never attained any degree of skill in making framed structures, whilst the wood carver hewed it into form much as if it were stone and his work is characterised by the boldness of its outlines and the grotesqueness of the forms which were called into existence by the weird fancy of the ancient sculptor. The temple cars were huge structures with solid wooden wheels which are obviously the design of men accustomed to work in stone and the carving with which they are lavishly adorned is equally of lithic origin.

Metal-work in brass and copper was almost always cast by the *cire perdue* process, and it is only since sheet metal began to be imported from Europe that the methods and patterns of the silversmiths have been extensively copied. Beating out thin sheets of metal was a very arduous business and was mainly confined to silver which is comparatively easy to work. Swamis, lamps, panchapatrams and spoons were needed for every domestic shrine and in the manufacture of such articles great skill was often displayed, though the modeller was rather at a disadvantage owing to the conventional restrictions by which he was bound. The metal workers are now mainly engaged in making household utensils which are usually but slightly decorated, but those used on ceremonial occasions are often of ornate character and excellent design. The growing wealth of the country has led to a much greater demand for metal ware than was ever possible before, and it may be said without the least hesitation that as good work is now being done in India as was ever done, though it must be admitted that a vast amount of cheap and inferior stuff is always in evidence.

Weaving gives employment to the largest number of artizans, but the bulk of the work is of a purely industrial character and, except when the cloths have a solid border, seldom possesses any artistic merit. There was a large migration of Mahratta weavers to the South of India some centuries ago and large colonies of their descendants are still to be found in the principal weaving centres. It is probable, therefore, that the Dravidians never attained to the high standard of weaving reached in the North of India, and the present general high level is due to the immigrants who settled in Salem, Tanjore and Madura, probably after the break up of the Vijayanagar Kingdom. Hand printed cottons have always

been a famous Madras industry, and palampores, curtains and table covers are still made in quite a number of towns, the most celebrated being those from Masulipatam, Kalahasti and Kumbakonam.

The carpet industry is in anything but a flourishing condition and its decadence is largely due to exploitation by traders whose sole idea was to produce showy articles manufactured at the lowest possible price. To meet the demand for cheap carpets the use of vegetable dyes has been abandoned but this would have been a small matter if the dyers had been able to acquire a knowledge of how to use appropriate coal tar dyes. Unfortunately they have not done this and any dye stuff which will produce a temporary colouration in the wool has been employed, with the result that the carpet industry in the South of India may be regarded as dead and beyond any possibility of revival. It is true that efforts are still being made in this direction, but it is equally true that such efforts have so far proved futile, and the reason is not far to seek. There is difficulty about getting local supplies of wool, lack of knowledge as to how to treat it and finally the prices which can be obtained for even the best South Indian carpets do not offer a living wage to the weaver.

Of minor art industries there are many in the South of India. Embroidery, in the hands of enterprising Mahomedans, has reached a very high standard of excellence and much of it is sent to other parts of India or exported from the country. Ivory carving is chiefly carried on in the Travancore State, and, as through the efforts of the Trivandrum School of Arts it has become widely known, there is a ready market for it at prices which should be remunerative to the carvers. The same may be said of the beautiful sandal wood carving of Mysore, which is seen at its best in the

panels of the caskets which are commonly made. The subjects are generally taken from the Mahabharata, but occasionally illustrate scenes of every day life. Much of it however suffers from imperfect drawing and ignorance of anatomy. The old conventionalism has been abandoned and the attempts at realism are somewhat crude. Comparatively little lacquer work is done in the South of India and that chiefly for the decoration of musical instruments, such as the Veena, but the art still survives in Kurnool and has been revived to some extent by the efforts of the Victoria Technical Institute. The goldsmith and jeweller are to be found all over the country, but the best work is naturally done in the large towns. The influence of modern European jewellery has resulted in greater perfection of mechanical details, but the designs have sadly deteriorated.

The object of the Swadeshi Movement is to try and cultivate among Indians a taste for home made articles and in no direction is there a more promising field than that presented by the Art industries of their country. I do not think it would be true to say that there is no movement at all in this direction, but at best it is a very slight one. None would deny the keen perception of beauty of form so generally prevalent in this country, but the ideas of the people in regard to Western Art are altogether lacking in taste and judgment. The educational system of the country makes no effort to provide for the cultivation of artistic instincts and till, in some way or other, this is accomplished we can hardly hope for any marked improvement in indigenous Art.

This is a field in which possibly the Victoria Technical Institute might do useful work. The native artist and craftsman is inarticulate and totally unable to express his ideas in words. But there are experts who have made a

special study of Indian Art and are filled with enthusiasm for its mysticism and grace and if they could impart some of that enthusiasm to the educated classes in India itself, it would be productive of greater results than are ever likely to be achieved by gorgeously illustrated hand books published at prohibitive prices, that serve to while away a few idle moments in a lady's drawing room. Let them be given opportunities to explain by word of mouth and to illustrate by actual examples the aesthetic principles underlying Indian Art to Indian audiences. Lectures such as I have in my mind would open out a new field of culture to educated Indians ; but—so far as I know—nothing in this direction has ever been attempted. Have we the men who can strike the right chord and revivify the dormant instincts and feelings of India in matters pertaining to Art.

CHAPTER X

WELL IRRIGATION

BORING FOR WATER

Since 1905, when we first began experiments with bore holes to locate supplies of underground water, we have put down more than 1,000 bore-holes and bored through upwards of 40,000 feet of ground. The results have been extremely satisfactory and have considerably increased our knowledge of the underground water resources of the districts in which this boring work has been conducted. There are about three quarters of a million wells in this Presidency, but except in a few favoured tracts the sinking of a new well is always attended with some degree of uncertainty as to the depth to which it will have to be sunk to reach the permanent water level and a still greater degree of uncertainty as to the quantity of water which it will yield. To a large extent this information can be obtained by a preliminary exploration of the ground with a bore-hole, which will reveal the nature of the material through which it passes. To interpret correctly the indications thus afforded requires local knowledge and experience and as our operations extend this is rapidly accumulating.

The cost of a well varies greatly, especially of a well which will yield a sufficient supply of water to be of any use for irrigation. It is very seldom less than two or three hundred rupees and often amounts to over a thou-

sand. Obviously it is worth while to go to some expense in preliminary investigations to make sure that the work is not undertaken in vain but there are serious difficulties in the way of private enterprise in this direction. A set of 3 inch boring tools, with steel lining tubes to penetrate to a depth of 50 feet, costs about Rs. 600 ; whilst a set of 4 inch tools which can be conveniently used for depths up to 200 feet or more, will cost about Rs. 1,500. Considerable experience is required to do satisfactory work with these tools and the men in charge of them have to go through a long course of training before they can be trusted to work independently. Boring as a method of exploring the ground therefore is beyond the resources of private individuals unless they be very large landholders. In the French territory of Pondicherry, where hundreds of artesian wells have been sunk, private individuals have found it feasible to take up this work but only because the conditions there are extremely favourable and there has been a very large demand for bore-holes. A private company started work in Madras, but it soon came to grief and it is not likely, at any rate for some time to come, that any boring work will be done by other than State agency. A boring outfit is very heavy and the cost of carting it to site and starting work is a big initial charge, but if a large number of bore-holes have to be put down in a comparatively small area this initial expense is distributed over the whole lot and the cost of boring is reduced to a reasonable figure.

In the alluvial deposits along the coast in the Chingleput district where some hundreds of borings have been put down the average cost of a 3" bore-hole is about 4 annas a foot up to a depth of 20 feet, thence on to 40 feet it costs 6 annas a foot, up to 60 ft. 12 annas, from 60 to 70 ft. Re. 1 and from 70 to 80 ft. Rs. 1-4-0

a foot. Beyond this depth the cost varies greatly and much depends upon the skill and experience of the man in charge of the work. Boring through rock is always expensive and naturally varies with the hardness of the rock, but the cost of the work remains the same through a considerable range of depth as lining tubes are not required.

We have recently made a few borings with an American drill driven by steam and there seems to be no question whatever that for deep bore-holes it will effect a great saving in the cost of the work. For boring through very hard rock we have also a petrol driven rotary drill which has proved very satisfactory so far as the speed of boring is concerned, but the cost of doing the work seems to preclude its general use. In searching for water for irrigation there is not much use in attempting to go to depths greater than 100 feet, unless there is a probability of tapping artesian or sub-artesian water and, so far as we know at present, this is only likely to occur in the alluvial deposits along the coast. To obtain a supply of water for domestic purposes, whether it be on a small scale for a village or on a large scale for a town, a much larger amount of money may be spent on investigation work than is practicable when a water supply for irrigation is looked for. For such cases power-driven boring tools may be employed with advantage, also for irrigation work when a large number of bore-holes can be put down comparatively close to one another, but ordinarily for the present, since it is not usually necessary to go to a greater depth than 100 feet, hand boring tools may be considered to be best adapted to the requirements of the ryots.

It may be interesting to briefly describe the way in which these tools work. Just as a hole is bored in wood

by means of an auger or bit, so through the soft strata of alluvial deposits holes can be made by similar tools of much larger dimensions. As the auger consists of a handle, a shank, and a suitable formed head carrying a cutting edge, so the boring tools are similarly constructed. Various types of auger head are used and these can be screwed to steel rods which are usually 10 feet long, and as many as are necessary are employed to reach from the surface of the ground to the bottom of the bore hole. At the top there is a swivel head by which the rods can be lifted and what corresponds to the handle of the auger is formed by clamping iron levers to the boring rod at a convenient height above the ground so that men, by walking round in a circle, can rotate the auger. When the material to be bored through is fairly stiff the auger takes the form of a worm or an open shell, and from time to time it has to be lifted from the hole to remove the clay which has gradually worked into it. When the soil is of a loose character, the auger has to be fitted with a shell to hold the material removed by the cutting edge, otherwise it would fall back into the hole whilst lifting the auger to clean it. These shell augers are fitted with various forms of cutting edges to suit the nature of the material to be removed, which may vary from fine sand to soft sandstone. When hard rock has to be pierced rotary tools worked by hand are not effective, as the speed of working is too slow and recourse must be had to the percussive action of variously shaped chisels for breaking the rock. The chisel is attached to the boring rods and a heavy blow is given by lifting them a few inches and allowing them to drop. Care must be taken that each blow of the chisel is on a different diameter in the bore-hole, otherwise the chisel will get jammed and possibly prove very difficult to loosen. When the chisel

has powdered a sufficient quantity of rock, it is withdrawn from the hole and a plain shell lowered by a rope which, when it is rapidly jerked up and down in the water at the bottom of the hole, collects all the loose material in the tube above the valve. In addition to chisels and augers it is necessary to have a number of special shaped tools for performing specific operations, the most important of which are the recovery of broken tools. To work a set of boring tools a derrick is required and it may be conveniently made of casuarina poles. At the top of the derrick is fastened a pulley over which the lifting rope passes from the swivel head to the winch. This latter is usually attached to two legs of the derrick and should have a lifting capacity of at least two tons. When the hole is bored through soft material it must be protected by lining tubes which are forced down as the boring work proceeds. Usually the tubes can be got down by screwing them into the hole, but, if they should happen to stick, a driving head is placed on the top of the pipe and the methods commonly employed in pile driving resorted to. If the lining tube has to pass through a layer of stiff clay, the work is facilitated by rymering the hole bored out by the auger to a larger size. In alluvial deposits lining tubes are always necessary as thin layers of sand are sure to be met with, which will run into the hole unless excluded by a lining pipe. In hard clay or disintegrated rock they can usually be dispensed with. The lining tubes used for exploratory boring work are made of steel with very carefully formed screwed joints and are naturally somewhat costly.

As soon as the bore-hole is finished, and all the information that can be got from it obtained, the lining tube is withdrawn and can be used an indefinite number of times. Considerable difficulty is frequently experienced

in drawing the tubes from deep bore-holes and at the present time I have a gang of men at work slowly raising some 5" lining tubes with two 20 ton screw jacks. These tubes have been in the ground for sometime and an upward pressure of at least 40 tons was required to start them. When a bore-hole is to be permanently lined much cheaper tubes will suffice as they need only be strong enough at the joints to stand being forced into the bore-hole. To tap a sub-artesian or artesian supply usually means putting down two bore-holes. The first bore-hole is put down to determine the existence of the water-supply and the depth at which it can be tapped, whilst the second is put down to form a permanent connection with the water bearing deposit. This second bore-hole may with advantage be considerably larger than the exploratory hole.

The principal sources from which subterranean water can be obtained are beds of sand, and rock which is highly fissured or partially decomposed. The object of putting down a bore hole is to locate these deposits, and obtain information as to their physical characteristics. The sand deposits, may be on the surface or at any depth below the surface in the alluvial soil. They may be composed of particles as fine as the sand found on the sea shore, or they may be extremely coarse and so mixed with stone as to almost justify them being termed gravels. The fine sand contains as much water as the coarse, but it is much more difficult to remove the water from the sand, and the hydraulic gradients necessary to produce movement through fine sand are extremely steep. To form an estimate of the water yielding capacity of any sand deposit revealed by a bore-hole, the character of the sand must first be examined by passing it through sieves of different mesh and the percentage of sand obtained on each sieve noted.

Broadly speaking, it may be said that the water yielding capacity depends, partly on the coarseness of the sand and partly on the absence of very fine grains which would fill up the interspaces between the larger grains. If the sand in this respect proves satisfactory, the bore-hole should be continued through the sand to determine its thickness and the character of the deposits upon which it rests. If the bed of sand is thick and rests upon an impervious layer the conditions may be considered satisfactory and to make an accurate forecast of the prospects of a well it is only necessary to know the superficial extent of the bed. This can be ascertained by putting down trial-borings at some distance from the site of the proposed well. It may happen that the deposit of sand is overlaid by impervious strata and if such be the case it is almost certain that the water in the sand will be under some degree of pressure which will cause it to rise in the bore-hole.

In searching for sub-artesian water it is always desirable to utilise, if possible, existing wells and start boring from the bottom of them. The wells can easily be kept dry and the deeper the well, the more readily will sub-artesian water will be detected. When a bore-hole has been started from the surface of the ground and a deep lying bed of sand is met with, the use of a bore-hole pump will give valuable indications as to the quantity of water likely to be within reach. If it is found that a considerable quantity of water can be drawn from the bore-hole by means of such a pump it is always worth while to sink a well round the bore-hole, which should be carried to a depth of 8 or 10 feet below the static level of the water in the bore-hole. The upper length of the lining tube may then be removed and water will flow into the well. By baling out, an accurate determination can be made of the quantity passing up the bore-hole. From these data experience will

enable us to determine the value of a source of water and the steps to be taken to obtain it. Generally, in place of the exploratory lining pipe it is advisable that a much larger permanent tube should be sunk to tap the water.

Formerly it was thought that water existed under artesian conditions in but a few places in the south of India, but the recent boring work shows they are fairly common in the alluvial deposits along the East Coast. They have been found in the Godaveri, at Ellore, in the Guntur District, over quite large areas in the Chingleput and South Arcot Districts and in isolated places elsewhere. The greatest development of artesian water is in the neighbourhood of Pondicherry where the wells overflow the surface of the ground. So many wells have been sunk in this tract that the pressure is now comparatively feeble and much larger quantities of water could be obtained if they ceased to treat them as flowing wells and adopted methods similar to those which have proved so successful with artesian supplies which do not rise to the surface of the ground. In Madras there is an extremely interesting example of an artesian or sub-artesian well in the compound of the Napier Iron Works, but it is in the village of Surapet on the banks of the Korttalaiyar river that supplies of artesian water have been most extensively developed. There are a number of engines and pumps lifting the water from brick wells sunk round the bore-holes and one, in particular, yields a continuous supply about 30,000 gallons per hour.

The essential condition for the establishment of an artesian or sub-artesian supply from deep seated beds of sand is that the latter should be covered by a thick layer of stiff clay impervious to water. The lining pipe should not penetrate the sand but terminate on the under side of the clay. As soon as the sand is reached there will be a

strong rush of sand and water into the well, but after a time this will cease and a cavity will be formed under the clay of such size that the movement of water in the sand towards the borehole will not be sufficiently rapid to carry the sand in suspension. The clay must be stiff enough to form a stable roof over this cavity, as a bore-hole sunk into sand without this protective cover invariably chokes up. Our experiments show that strainers fixed at the bottom of bore-hole pipes have not been successful as they do not offer a sufficient area through which the water can filter into the pipe. In the coarse gravel deposits met with in America such straining tubes have proved eminently satisfactory, but it would appear that in India even the coarsest beds of sands are too fine to admit of their being adopted, except possibly for small domestic supplies of water.

Turning now to wells sunk in rock, we find that a good water supply depends almost entirely upon the presence of extensive fissures, though of course the fissures themselves are fed with water by percolation from the porous rocks through which they run. The geological structure of Southern India is extremely unfavourable to the draining of large tracts of land at any one point and the most we can hope for is numerous wells holding a moderate supply of water. Experience has taught the people that rock wells must be large and deep. Bore-holes sunk in the bottom of these wells frequently connect up with additional fissures which contain water under a certain amount of pressure and if the water in the main well is kept at a low level by constant baling the flow up the bore-hole is encouraged. The chances of opening up communication with fissures are considerably increased by torpedoing the bore-holes ; that is to say, by exploding a considerable charge of dynamite whereby the rock round

them is shattered. As to the value of such torpedoing our experiments are not sufficiently numerous to be conclusive. In many cases they have been distinctly successful, but the conditions which determine the result of torpedoing have not been definitely ascertained. It would seem that in fresh rock, or in rock, that is but slightly fissured, the effect is negligible, whilst in partially disintegrated rock, especially when highly fissured, the effect of the explosion is to greatly increase the area through which the water can get into the bore-hole. The evidence collected by the Pumping and Boring Department all points to the necessity for much deeper wells and such deep wells for irrigation are rendered possible by the use of power-driven pumps which have proved capable of lifting the water at much less cost than when cattle power is employed.

A NEW WATER-LIFT

The area under wells in British India was reported by the Irrigation Commission to be not less than 13,000,000 acres. In all India, including Native States, it is now over 16,000,000 acres. The cost of irrigation varies with the crops, the minimum being about Rs. 10 per acre for wheat to a maximum of Rs. 30 an acre for paddy. Perennial crops, such as sugarcane, and garden crops, such as plantains and betel nut, cost not less than Rs. 5 per acre per month. Under wells two crops a year are usually grown and an average expenditure on lifting water of Rs. 25 per acre per year will be within the mark. For 16 million acres this amounts to 40 crores of rupees, which is truly a heavy burden to place upon agriculture, and be it remembered a burden which is growing year by year as the area under lift irrigation extends and as the value of labour and the cost of cattle food increases.

The Land Revenue of all India is about 30 crores of rupees and we hear much from politicians and platform orators about the oppressiveness of this tax or rent, call it which you like, but singularly little about the cost of lifting water, which at any rate taxes the ryots on about 6 per cent. of the area under cultivation, to such an extent that he pays in one form or another the equivalent of at least one and one-third times the Land Revenue. The gross revenue from State irrigation works is a little over five crores of rupees and this is levied on an area of nearly twenty million acres. The cost of irrigation to the fortunate owners of land under these works is, therefore, approximately one-tenth the cost of irrigation under wells. These figures should be carefully studied both by those in charge of the irrigation interests in this country and by those who are vigilantly searching for defects in the administrative machinery of Government.

The great Tungabudhra project, which, if ever carried out, will probably cost twenty crores of rupees and will supply water to possibly two million acres of land, has been indefinitely postponed because, at the current rates levied on wet lands supplied from Government channels, it will impose a permanent burden on the finances of the country which is deemed unjustifiable. If those rates were increased 50 per cent. the project would pay its way ; if they were doubled it would yield a magnificent return. I do not dogmatically assert that the ryots on the lands which would be irrigated by the Tungabudhra project would benefit enormously if it were carried out and they had to pay such higher rates, than now commonly levied, as would make the project a perfectly feasible one ; but I do contend that investigations in this direction are desirable in view of the fact that ryots can cultivate paddy under wells and pay Rs. 30 per acre for

lifting the water. There are many other irrigation schemes hung up for the same reason. The future progress of India will be seriously delayed if more accurate ideas regarding the value of water for irrigation are not to influence the construction of the great public works which alone can place at our disposal the invaluable water now running uselessly to the sea.

This is somewhat in the nature of a digression from the question of well irrigation, but it is a legitimate conclusion to draw from the vast expenditure on lifting water and there is a great need that those who understand these matters should use all available opportunities to create an intelligent public opinion thereon. If Indians, who by their position and influence command the respectful attention of their countrymen and of the authorities responsible for the Government of the country, would turn their attention to these very practical problems and make themselves acquainted with the issues involved, they would do a great public service.

From more than one point of view the vast expenditure on lifting water for irrigation is a matter of great importance and it is unfortunate that it has not attracted the attention of engineers to any great extent.

It is true that we have done something of late years with oil engines and centrifugal pumps, but that involves a scale of operations which can only be applied to a combination of conditions that comparatively rarely exists. The wells and other sources of water-supply capable of feeding centrifugal pumps are only found in favoured localities and to make use of them to this extent means a large outlay of capital and a sufficient area of land to make proper use of the water. The land is always there, but often split up between many owners whose powers of co-operation are too feeble to jointly undertake a pumping

scheme. The ordinary ryot has still to water his land in the way his forefathers did and everywhere through the length and breadth of India will be seen rude contrivances for lifting water, which are, when the circumstances of the ryot are fully considered, nevertheless wonderfully effective. Not a few attempts have been made to improve them as the records of the Indian Patent Office will show, but for one reason or another only a very moderate degree of success has been attained.

At one time I held the opinion that it was almost hopeless to try to improve indigenous methods of lifting water and in one sense I still adhere to that opinion, as the picottah and the mhote, when properly adjusted to the work to be done represent as near perfection in the way of applying man or animal power as is conceivable, but with increased experience of the ryot and greater knowledge of this problem I am convinced that it is now possible to introduce new methods of lifting water which will reduce the cost of that operation very considerably and that their general use will effect a very large annual saving —one which may be counted in crores of rupees. What we want are mechanical appliances to work on a smaller scale than is efficiently possible with the centrifugal pump and in this present article I propose to describe a new development in this direction which lately occurred to me and which though perhaps not yet perfected in regard to the details of its construction, is sufficiently advanced to be recommended for use by those in search of a simple appliance for lifting water which is both efficient and cheap.

As is now well-known the Department of Industries has a number of boring parties at work exploring the sub-soil for water bearing strata and in the course of the last few years has put down over 1,000 bore-holes to depths

varying from 50 to as much as 200 feet. Many of these are started from the bottoms of existing wells and in certain parts of the country they have revealed very valuable sub-artesian supplies. That is the bore-hole tube, after passing through an impervious bed of clay, enters a bed of sand containing water under sufficient pressure to cause it to rise in the bore-hole and flow into the well till the water in the well rises to such a level that its pressure is equal to that of the water in the sand and then the flow ceases. By drawing water from the well either with a mhoté or a pump the static equilibrium is disturbed and flow again occurs. By adjusting the capacity of the pump to the size of the bore-hole and the pressure of the water at its base, a continuous flow can be obtained. But in most instances the pressure is not sufficient to cause the water to rise to the ground level or the free surface of the water in the well and the only way to test what has occurred, when a bore-hole reaches a water bearing layer of rock, is to introduce a pump and withdraw from it as much water as possible. For this purpose lift pumps were specially designed to work in bore-holes but they proved exceedingly troublesome and raised so little water that they were seldom used and it is possible that many bore-holes recorded as failures may have penetrated useful water bearing deposits. While testing a borehole in this way it occurred to me to dispense with the usual type of piston and to employ a loose tubular piston which could be worked with a rope and required no pump rods to force it down again. Accordingly a few lengths of gas pipe were screwed together and a plain hinge valve made of leather weighted with an iron plate fitted at the bottom. For the piston a short length of gas pipe, which would just go inside the long pipe, was used and a similar valve fitted to it. A piece of iron rod bent into an inverted U was

riveted to the upper end of the piston pipe and the rope attached to it. At the upper end of the discharge pipe a pulley was fixed to carry the rope and the pump was complete. When used on the borehole it proved admirably adapted to the work and could be erected and taken down in as many minutes as it took hours to adjust the pump previously employed, whilst, having no defined pump chamber, it could be worked at any depth and with any convenient length of stroke. A gang of coolies at the end of the rope pulled it back and raised the piston causing water to flow out of the pipe, whilst by letting the rope go slack the piston fell back again and was ready for another stroke.

For testing bore-holes, or for permanent use in them, I have but little hesitation in saying that it is the simplest type of pump ever designed and probably as efficient as any. Obviously the pipe might be fastened to the side of a well instead of being hung in a borehole and experiments in this direction were tried. To pull the rope with the arms is a very ineffective way for a man to work and it is much better that he should be able to apply his weight to the end of the rope, descending a few feet whilst the piston rises to a corresponding height. This was easily arranged by constructing a see-saw platform and attaching the rope to one end whilst the other was loaded to almost but not quite counterbalance the weight of the piston so that at rest the piston is always at the bottom of its stroke.

To work the pump the platform is set oscillating with one foot and the water immediately begins to rise in the pipe and as the resistance increases, more and more pressure is put on the platform till finally, the water begins to flow and the man puts his whole weight on the platform, which descends about 3 feet, he then steps off

and raises himself by a step at the side to a position from which he can conveniently get on the lift as soon as the piston has fallen back in the pipe to the bottom of its stroke. Tests with this lift show that a man weighing 110. lbs. can raise 20 gallons a minute to a height of 15 feet, but this is admittedly hard work and to keep going for any length of time he must work at a slower rate. When he is accustomed to the motion of the lift and able to go through the cycle of movements with the minimum of exertion he can easily raise 15 gallons a minute to a height of 15 feet with is equivalent to doing 2,250 foot lbs. of useful work. The lift will work conveniently over a wide range say from 5 feet to 60 feet, the quantity of water raised being inversely proportional to the height of the lift. Similarly the diameter of the pipe should vary and the following tabular statement show the limits for each size of pipe :—

Diameter of pipe. Max. Lift in feet. Discharge in Gallons per hour.

6"	6 $\frac{1}{2}$	2,400
5"	9	1,500
4"	15	900
3"	25	550
2 $\frac{1}{2}$ "	40	330
2"	60	200

With two men working the lift, either double the quantity can be raised or the same quantities can be raised to double the height. The advantages of the lift are (1) that it can easily be worked by one man, whereas a picottah cannot be worked by less than two men, and, to obtain good results from it, must be worked by three men ; (2) that it requires no special skill to work it and the platform being on the ground level is perfectly safe, whereas the picottah requires trained men and working it is regarded as a hazardous occupation ; (3) that it can be easily constructed and whilst not likely to get out of order can be

repaired by any village artizan ; (4) that it can be employed to lift water from depths ranging from 6 to 60 feet and is thus suitable for any well, whilst the picottah has a very much smaller range and cannot be used for depths over 20 feet and is best adopted for a lift of from 10 to 15 feet.

From the above statement it is clear that the lift is suited to the needs of the poor man who cannot afford to employ cattle to water his land or hire men to work a picottah. Against it is the fact that it cannot be made entirely from country materials but the gas pipes are not expensive and should last for many years. Wet cultivation is very profitable and this lift renders it possible for the small ryot to indulge in at any rate a patch of such cultivation. In many places pot wells can be sunk to a good supply of water for a few rupees and this lift, so far as I know, is the only one that can be applied to such wells. For village water supplies it meets a much needed want. At every well one might be set up and the water raised into a small tank from which it could be drawn off by taps. This would secure the water in the well from contamination, as the top could be closed in, since there would be no longer any necessity to lower the water pots into the well. Lastly, the lift, can be used on a bore-hole, pure and simple if it taps a sufficient supply of water.

There is no great mechanical difficulty in arranging for the lift to be worked by cattle but I have not yet constructed one and I am not at present prepared to recommend it for such a source of power. The ordinary cattle gin could be used to drive a double pump but it is at its best an unsatisfactory way of employing cattle and I am in doubt if it would prove any better than a mhote.

If, however, a small engine be employed as a source of power, it seems certain from the experiments already made in Madras that it has a wide field open for it.

The great majority of wells in this country do not yield sufficient water to give continuous employment to a 3" centrifugal pump which will lift about 10,000 gallons of water per hour and is the smallest size that can be efficiently employed for irrigation work. Moreover, it is not very easy to arrange to drive the centrifugal pump when the well is very deep. It is true that vertical spindle pumps might be used, but they are expensive and will require careful looking after. What is wanted in this country is a mechanically driven pump which will lift from 3,000 to 4,000 gallons of water per hour from any depth and this pump lends itself admirably to such work. By employing suitable gearing, which is of a very simple character, a double pump can be arranged in which all the moving parts balance one another, and with a small engine of from 2 to 3 H. P. the pump is capable of lifting up to 5,000 or 6,000 gallons of water per hour on a lift of as much as 60 feet. On such high lifts both the piston and the pipe in which it works should be made of cast iron and should be turned and bored so that the clearance may be as small as possible. This greatly reduces the slip which would otherwise occur. It adds to the cost of the pump, but even then owing to its great efficiency it is very much cheaper than any other arrangement. To secure smooth working, the chains which carry the pistons must never be allowed to get slack and it is found in practice that this limits the speed of working to about 20 strokes a minute, the length of each stroke being 3 feet.

UNDERGROUND WATER IN MYSORE

Ten or twelve years ago I wrote a short article in the "Indian Review" on "Underground water supply", the object of which was to point out that the small yield of

wells in the Madras Presidency was due to the fact that they were not deep enough and that the reason they were not sunk deeper was due to the feeble appliances which the ryot could command to unwater the well during the process of sinking or excavating it. I pointed out that, in the majority of cases, the minimum capacity of the well to supply water at the end of the dry season would be less than the capacity of the water-lifts employed during the construction of the well, and I suggested experimenting with oil engines and centrifugal pumps to ascertain whether much larger supplies could not be obtained with these more powerful modern methods of raising water. The article attracted the attention of the then Chief Engineer for Irrigation, Col. Smart, R. E., and he obtained the sanction of Government to the provision of funds in the Public Works Department and the first experiment was made with the co-operation of the Rev. A. Andrew at his Mission Settlement at Melrosapuram.

Since then we have moved a long way and the old ideas about the limited quantity of underground water available for irrigation have been proved to be erroneous. The establishment of nearly 400 pumping stations has provided very definite information on the point over widely scattered areas and the records of nearly a thousand borings have disclosed the fact that at depths much beyond the reach of ryot with his unaided resources there exists an abundant supply of water. To get at this water in sufficient volume for its profitable use and to provide means to bring it to the surface in the cheapest possible way has been an important part of the work of the late Department of Industries and will continue to be an object of solicitude on the part of Government in whatever department it is finally decided that the development of agricultural engineering shall be carried on.

The Government of Bombay have for some time past employed an engineer to design and carry out small irrigation pumping plants on somewhat similar lines and in the United Provinces the improvement of indigenous methods of lifting water has long occupied the attention of Mr. Moreland, the Director of Agriculture. Apparently, the Mysore Government has also given the question serious consideration, though their primary object was the improvement of the water supply for domestic purposes, as Geological Department of that State has recently published a volume "Notes on Underground Water-Resources in Mysore" which has been prepared by Dr. W. F. Smeeth, the State Geologist. From a careful study of the information collected by the local officers of the Public Works Department regarding 2,563 wells scattered all over the State, Dr. Smeeth has arrived at some very important results. The investigation is an excellent piece of scientific work which is worthy of being made more widely known, in the hope that it may stimulate others to further inquiries in this direction. To this end I propose to briefly describe the evidence collected by Dr. Smeeth and then to examine his conclusions in the light of the information we have gathered in Madras during the last few years.

The Mysore Plateau lies at a level varying from two to three thousand feet above the sea and is almost entirely composed of old crystalline schists, gneisses and granites. The rocks in their fresh condition are but slightly permeable to water, but over the greater part of the area they have been subjected to weathering action with the result that to an average depth of about 50 ft. extensive decomposition has taken place and the character of the rock so changed that it is readily permeable to water. The porosity of the complete-

ly decomposed rock, immediately below the surface soil is estimated at from 30 to 40 per cent., and that of the highly decomposed rocks in the next layer at from 16 to 24 per cent., gradually decreasing as the effect of weathering diminishes with increase of depth till in the unchanged rock it is so small as to be negligible. The records of the wells which have been examined show that the water level varies very considerably during the year and that the range of variation is greatest where the water level is nearest to the surface. For the State, as a whole, Dr. Smeeth comes to the conclusion that the level of permanent saturation is about 50 ft. from the surface and that above this level there is a zone of intermittent saturation which averages 8 ft. in thickness. The evidence furnished by the wells justifies the conclusion that, the nearer the surface, the thicker is the zone of intermittent saturation and the greater the porosity of the rocks. Allowing for this Dr. Smeeth assumes that the zone of intermittent saturation extends to a depth of 10 ft. and possesses an average porosity of 12 per cent. and therefore contains 14.4 inches of water. Under no circumstances does this zone of intermittent saturation ever become dry, but there is evidence to show that during the three or four months of the hot weather about 40 per cent. of the contained water drains away and the assumption is made that during the rest of the year an equal amount of water is removed. The total loss then amounts to about 12 inches or 10 per cent. of the depth of the zone. Now the rainfall varies from 73 inches in the Kadur district to as little as 22 inches in the Chitaldroog district and it is a somewhat remarkable conclusion to arrive at, that the per centage of water penetrating to such a depth, as to reach the surface of saturation, should be approximately the same in each

district. Yet such is the fact disclosed by the yearly variation of the water level in the wells. In the Kadur district it is 12.84 feet and in the Chitaldroog district 11.39 ft. whilst in Bangalore, which enjoys an average rainfall of over 30 inches, the variation in water level is only 10.82 ft. From this it would appear that the fluctuations in the level of saturation are independent of the rainfall on the surface and that whatever the rainfall may be, only about 12 inches of water per annum can pass through the surface and sub-soil to the level of saturation. The rest either runs off by direct flow or after penetrating to a certain depth is returned to the surface by capillary action and dissipated by evaporation. I am not aware that any similar conclusion to this has been deduced from observations in other parts of the world and it would be interesting to ascertain what happens under widely different surface conditions.

The rate at which the surface water filters down to the permanent subterranean water level probably varies very much, but from these results it would appear that, within the limits recorded in Mysore, rainfall is not an important factor in determining the rate. The uniformity of the rate of percolation over so wide an area as the whole of the Mysore State is probably due to an equal uniformity in the character of the soil due to the prevalence throughout the whole area of similar geological conditions.

The statistics of well irrigation in the Madras Presidency tend to show that where the rainfall is least, there well irrigation is most highly developed. I purposely only say "tend to show," because there are other factors influencing the extent to which well cultivation is possible such as the presence of black cotton soil and the general status of the community in regard to a gricultural and industrial pursuits.

Put in plain figures the quantity of water temporarily stored in the zone of intermittent saturation amounts to 270,000 gallons of water per acre or 170 million gallons of water per square mile. Some interesting light is thrown upon the accuracy of these calculations by data furnished regarding the pumping at the Kolar Gold Fields. The area drained by the pumps in the mines is certainly less than 5 sq. miles and the actual quantity of water raised per annum is 546 million gallons or something over 110 million gallons per square mile, that is to say, two-thirds of the water presumed to be present is actually dealt with by the pumps and this must be taken to be satisfactory justification of Dr. Smeeth's deductions, since they are based on data that are admittedly rough and can under no circumstances be very accurate.

There can, I think, be no doubt that Dr. Smeeth is justified in stating that "throughout the Mysore State there is a permanent zone of water at a moderate depth below the surface and that above this there is a variable zone which fills and empties annually." The volume of water in the intermittent zone is surprisingly large and it would be interesting and possibly of great practical value if we could ascertain with some precision the mechanism of the arrangements by which it is disposed of. Of course there is an underground lateral flow, but whether that is an extremely slow movement through a great thickness of rock or whether it mainly takes place through fissures and cracks is not definitely known. All the available evidence, which comes from the various mines, supports the conclusion that except by fissures the water does not penetrate to any great depth, as at 300 ft. sound rock is found to be invariably quite dry and it is certain that there is no movement of water through it. The lateral movement of water must therefore be through the superficial

layers of decomposed rock, but from an examination of a large number of rock wells I am certain that such movement must be extremely small and will not account for any appreciable proportion of water that drains away. Dr. Smeeth's conclusions show that we have to deal with about eight-ninths of a cubic foot of water per second from each square mile of the country, and it is not difficult to imagine that the faults and fissures in the rocks near the surface provide a sufficient waterway to easily dispose of this flow with the hydraulic gradients available. The important question to determine is whether information regarding the geological structure of the country can in any way be used to locate the places where these fissures are most numerous and carry the largest quantity of water. There is not enough evidence available at the present time to discuss this question profitably, but it suggests that there might be some advantage in examining the wells of the country in reference to the geological structure. Along rifts or main lines of faulting it is possible that there may be a concentration of subterranean flow, but unfortunately for practical purposes it is likely to be at a very considerable depth.

Dr. Smeeth discusses the influence of baling upon the water level in wells and conclusively proves that "the effect of baling is not to increase the annual variation but to gradually lower the water levels as a whole down to some limit depending on the quantities baled and on various natural factors which tend to reduce the annual loss of the zone." The opinion is very generally held by ryots, not only in Mysore but also over wide tracts of the Madras Presidency, that the water level in wells has been gradually falling for many years past and there is no doubt that this is to some extent accounted for by the enormous increase in well cultivation which has

been going on in recent years. It is important to remember that the volume of water available for raising to the surface remains the same, but lowering the water levels involves an increase in the work of lifting the water and, what is even of greater importance, to a considerable increase of capital outlay in deepening the wells to get at the water. From the information collected regarding the wells in Mysore, Dr. Smeeth comes to the conclusion that they are not sunk deep enough, that many of them only penetrate the zone of intermittent supply and that few go deep enough into the permanent water zone to yield a large supply at the period when the water levels are lowest. To cause flow from the surrounding strata into a well, there must be a head of several feet and as the hydraulic gradient is necessarily a steep one, the withdrawal of a large quantity of water creates a gradually increasing cone of depression of the water level round the well. This may be counterbalanced to some extent by fissure water coming from a considerable distance, but where fissures do not exist, a well to yield water all the year round must be sunk to a considerable depth below the line of permanent saturation. To sink these deep wells is beyond the means of the ryots, as not only is the rock hard and only to be removed by blasting, but temporarily there is an abundance of water which is beyond the capacity of their mhetes to deal with. Their practice therefore when the well dries up is to sink another well in the immediate neighbourhood in the hope of striking better fissures, but of late years, especially in the Coimbatore District, they have taken to jumping holes to a considerable depth in the hope of striking additional fissures. On the whole, the practice is justified by the results and the chances of increasing the water supply are somewhat enhanced by torpedoing these holes or exploding a charge of dynamite

at the bottom of them. The explosion shatters the rock and greatly increases the probability of opening a connection to fissure water. Sometimes this fissure water is under sufficient pressure to deliver a considerable stream at the mouth of the bore-hole, but in many cases which are now regarded as failures, it is not improbable that a bore hole pump would be able to extract a considerable quantity of water which cannot now rise to the mouth of the bore-hole, owing to deficiency of pressure in fissures. Our experience in the Madras Presidency, in those parts of the country where the conditions are somewhat similar to those prevalent in Mysore, confirms the conclusions arrived at by Dr. Smeeth, and I would strongly emphasise his advice regarding the use of boring tools. We have done a good deal of boring in hard rock with hand tools, but it is a very slow and expensive process and we are now experimenting with various forms of power driven drills.

The Mysore Government have in view the improvement of wells for domestic water supply, and I have no hesitation in confirming the advice tendered by Dr. Smeeth in regard to this matter. Working on similar lines but with the object of getting greater supplies of water to be used for irrigation we have met with a considerable degree of success, and if it had been with us merely a question of getting at few hundred or thousand gallons of water a day we should hardly have a single failure to record.

WATER-LIFTS *

In the report of the Irrigation Commission, which for statistical purposes is now perhaps a little out of date, it is stated that in the United Provinces there are 500,000 permanent wells and 830,000 temporary wells irrigating in a normal year 5,731,000 acres. The average lift

* The Agricultural Journal of India, July, 1911.

is probably not less than 30 feet and in the aggregate the amount of work done by cattle power in lifting the water for the irrigation of this vast area is enormous and the cost to the ryots of the country an annual sum which may be more than, but certainly cannot be far short of, 10 crores of rupees. This is not all, as besides the area under wells, there is much irrigation under canals, *jheels* and swamps which involves lifting the water. It is true that the lift in these cases is seldom more than a few feet, but most of the work is done by hand and human labour is invariably more expensive than cattle power.

I do not pretend to any great accuracy in the above statements, which are only made to illustrate the importance of water-lifting in these Provinces and the necessity for carrying out such work in the most economical manner possible. That it is not so done goes without saying, but the extent to which improvement is possible is quite unknown. It is a matter for the State to deal with, as the problem is far too difficult for private individuals to tackle, and there is but little chance that any adequate solution would yield a direct pecuniary reward to the individuals who worked it out. It is mainly a question of adapting the means available under modern conditions to the end required, which is the lifting of small volumes of water through a moderate vertical distance. If the volumes were larger or the vertical range greater, the problem would be a simpler one. The real element of difficulty is to apply mechanical methods of lifting water to the small scale on which the ryot works.

I am not sufficiently acquainted with the ryots' methods of lifting water in the North of India to express any opinion on the possibility of improving them, but in respect to the South of India I feel fairly confident in

saying that the best practice of the ryots in their methods of applying animal or human power to lifting water is, if not perfect, exceedingly hard to improve upon. The *picottah* is a very efficient water-lift for heights ranging between 10 and 20 feet, and though at first sight it may seem that to employ one man solely to tilt the bucket and guide the lifting rod is a waste of energy, yet it is not really so, as by changing round from time to time each man gets a needed rest and the work goes on, without exhausting the men, for a longer time than would otherwise be the case. Similarly, the South Indian *mhote* with its leather or iron bucket and leather discharge pipe is, when worked on a steep incline on the *Kili* system, an excellent method of utilising cattle to draw water from a deep well. It of course involves the employment of two pairs of cattle and is not well adapted to shallow wells from which water may be drawn by the *mhote* worked on the *lagor* plan with one pair of cattle. Various attempts have been made to improve on these methods and some of them have had a certain amount of vogue for a time, but they have gone out of use and must therefore be classed as failures. The indigenous methods are the result of long experience and are probably an example of the law of the survival of the fittest—that is, of the methods of drawing water from wells which are most suited to the environment and resources of the ryots. Experience has taught the people of India that, to get the maximum amount of work out of men or animals, they must not apply their muscular efforts to the direct production of external work, but that they must, as far as possible, store kinetic energy in their bodies, and utilise the same by allowing their weight to act by the descent of their bodies. The *picottah* has a high efficiency because this principle is very perfectly carried out in that water-lift and the single *mhote* has easily held its own

against the double *mhole*, partly because of its simple character, but mainly because whilst descending a steep incline, the gradient of which is from 1 in $2\frac{1}{2}$ to 1 in 3, the animals automatically throw a very considerable proportion of their weight on to the yoke and thus are able to exert a much stronger draught than when walking on the level and therefore draw up a much larger bucket of water each time. Again, an animal like a bullock and still more a pair of them are able to exert a much stronger draught in a straight line than when walking in a circle. To attach a pair of animals to a gin or whim such as is very commonly used is to employ their muscular efforts in the most inefficient way possible. The smaller the diameter of the circular path in which they walk, the worse is the result. No ingenuity in the design of the water-lift worked in this way can altogether compensate for the defects in this system of employing animal power. In some instances, such as the common mortar mill, the cheapness and simplicity of the device compensates even for this defect, but in the case of water-lifts the possibility of using other and better methods of lifting water puts the gin out of court.

It is not unlikely that mechanical methods of lifting water will ultimately displace cattle power almost entirely, but that day is still far distant, and in the meantime it would be of great advantage to the agricultural community if authoritative and complete trials were made of the efficiency of the various indigenous methods of lifting water. Fifteen years ago with Mr. C. Benson, the then Deputy Director of Agriculture in Madras, I made some experiments in this direction which led me to the above conclusions, but it would be well if they could be repeated on a more extended scale and the relative merits of the different methods of applying power determined with

greater accuracy than was possible with the limited opportunities we then enjoyed for such experiments. Considering the enormous number of cattle power water-lifts at work in India, it seems to me that the interests involved will amply justify the trouble and expense of such investigation.

It is true that records exist of many tests of water-lifts but unfortunately the results are of no comparative value as every observer failed to measure the strength of the cattle employed. A pair of bullocks is a vague term ; one pair may be easily twice as strong as another and some way of comparing the strength of the animals must be devised. Failing any better method, I assumed that for animals and men in good working condition their strength was for each class proportionate to their weight, and though this may not be strictly accurate, there is no question that it does to some extent serve as an indication of the amount of muscular energy which can be obtained. Here it may be convenient to state that I obtained a very useful coefficient, or figure of merit, by dividing the useful work done in foot pounds per hour by the weight of the animals in pounds. My experiments led me to the conclusion that we were not likely to be able to effect any marked improvement in the indigenous methods of lifting water. The development of the internal combustion engine a few years later rendered it possible, however, to employ mechanical power in place of men or animals, wherever the supply of water exceeded a certain quantity, and opened out a new field for experiment and investigation. The American windmill also seemed worthy of trial and during the last nine years in Madras we have been working to adapt these entirely novel sources of power to the service of the ryot. With the windmills, we have not met with much success owing to

the general feebleness of the air currents, but it has been otherwise with the oil engine coupled to a centrifugal pump, as is attested by the fact that there are about 400 installations of this character at work in the South of India. The main objection to the oil engine and centrifugal pump is that it can only be worked economically when the quantity of water to be dealt with is large. Nine thousand gallons per hour may be taken as the economic minimum that the centrifugal pump can deal with and there should be enough water to keep the plant at work for about 6 hours per day. Any extension of these figures means increased economy, and the larger the unit that can be employed, the more satisfactory is the result. With sufficient water, the cost of lifting it is from one-fourth to one-tenth that of the older methods, and volumes can be dealt with and vertical lifts tackled that are absolutely beyond the range of cattle power. We are still only at the beginning of this revolution in lifting water for irrigation, and no one can doubt that as it extends, the increased experience will render it more efficient and more adaptable to the every-day needs of the smaller irrigators.

These preliminary remarks on the subject of lifting water are necessary to explain the standpoint from which the following notes have been written on the display of water-lifting machinery at the Allahabad Exhibition. As a spectacle, the show round the lake in the Agricultural section was impressive, but a detailed examination of the exhibits leads to the conclusion that the problem of lifting water for irrigation has not yet received the attention in the North of India which its importance deserves. The exhibits may be divided into three main classes, according to the source of motive power: (1) men, (2) cattle, (3) engines, and only in the third section was there anything like a complete representation of the

available methods. Indigenous methods of lifting water were conspicuous by their absence, and it is a matter of regret that no attempt was made to show one specimen at least of each of the methods of lifting water commonly used in various parts of India. For instance, in Madras we have quite a number of water-lifts which seem to be unknown in the North of India, and under suitable conditions the introduction might be attended with advantage. I might cite as examples the various forms of double *mhole*, the *picottah* and the Malabar scoop wheel. Where so much was done, it is perhaps ungracious to ask for more, especially as the erection and exhibition of these lifts in working order would have entailed much trouble and not a little expense on the authorities in charge of the Agricultural section.

Of water-lifts to be worked by men there were a great variety of pumps actuated by levers, all better suited for garden work and occasional use than for steady employment, day in and day out, on the irrigation of field crops. The only device really intended for irrigation was the chain pump exhibited by the United Provinces Agricultural Department. For low lifts up to, say 5 feet it is probably an effective device as the pump is very efficient, gives a continuous flow of water, and the only objection to it is the mode of application of the power which is extremely simple but very fatiguing. For lifts above 5 feet its utility is doubtful and at 15 feet it is only about half as effective as a *picottah*. From a circular on pumps issued by the Agricultural Department at Cawnpore I find it is stated that four men working 10 hours a day will lift 6,806 c. feet of water to a height of 15 feet in two days. Assuming that the men weigh an average of 120 lbs. each, I calculate that they will do 319,000 foot lbs. of work per hour, and this number divided by their total weight gives as a figure of merit or co-efficient of utility, 664. This

may be compared with a trial I once made with a *picottah*. The lift was $14\frac{1}{2}$ feet, and the three men employed weighed 331 lbs., and did 394,310 foot lbs. of useful work per hour—the co-efficient of utility being 1,191. The duration of the trial in this case was seven hours and the men worked in a normal way. This is by no means an unusually good result, and with an improved lift worked on the *picottah* principle, I have obtained co-efficients as high as 1,800. The chain pump is a very efficient water lift, but the rotary method of driving it, though it has the advantage of being very simple, is not an effective method of applying human power. I doubt if it would be possible to satisfactorily arrange any system of treadles or levers to be moved by the weight of the operators, and such being the case, the advantageous application of the lift is limited to raising water a few feet.

In all the lifts worked by cattle the gin was used and the cattle walked in a circle about 20 feet in diameter. The gins were well and substantially made, but the rotating arm was too short except for small cattle, and a pair could only be effectively employed by attaching one animal to each end of the rotating arm. This is unsatisfactory unless the animals can be trained to work without a driver to each of them. The gins were employed to drive chain pumps or *norias*. From data given in the circular of the Agricultural Department already referred to, it appears that the co-efficient of utility of a gin-driven chain pump works out at about 470, which is about as good a result as can be obtained with the single *mhote* worked on the *Kili* system and somewhat better than when they are worked on the *lagor* system. My practical experience with chain pumps and *norias* is too limited to justify me in expressing any opinion on their merits as water-lifts for ryots' use. I

once made some experiments on a *noria* and obtained a co-efficient of utility of 404, and from measurements made on the draught exerted by the cattle I found that as a machine it had an efficiency of 50 per cent. For low lifts the chain pump is undoubtedly superior to the *noria*, but on lifts of over 20 feet I have no information as to their relative efficiency.

Besides the bullock-driven chain-pumps and *norias*, there was exhibited a double trough water-lift called a "Baldeo Balti." I quote from the Agricultural Department circular the following description :—" It consists of two iron troughs, each having a valve at the bottom opening upwards. They are hinged on a beam fixed to the ground at discharging level and are alternately raised and lowered by ropes attached to the back ends of the troughs, passing over two pulleys and so to a horizontal beam pivoted at one end, which is pulled round by a single bullock walking in a circle." It is certainly a simple effective device for lifts of 3 or 4 feet, but its merits would be mainly determined by its efficiency and on that point I have no information. I am inclined to think it would be less efficient than a well-designed chain-pump.

It should be pointed out that chain pumps and *norias* are not suitable types of water-lift for wells in which the water level varies greatly. The load against which the power is exerted varies with the height to which the water has to be lifted, and as the water goes down, the strain on the cattle increases. On a *noria* the load might be diminished by removing some of the buckets, but in practice this is not a convenient arrangement. Cattle working a gin walk at a uniform pace and exert a steady draught and, to be employed in an effective manner, the load must be steady and proportioned to the draught they can exert. Obviously this is impossible with chain pumps and *norias*.

if the water level varies. At the beginning of the day's work the load will be too light, or if properly adjusted to the strength of the animals, then at the end of the day it will be too heavy. It is possible for this reason they have never found favour in the South of India where the Persian wheel is unknown and where the water level in the wells varies greatly.

The mechanical methods of lifting water may be conveniently regarded as consisting of a source of motive power and of a pump and that within certain obvious limits any source of motive power may be coupled to drive any type of pump. At Allahabad nearly every modern type of engine was at work in the exhibition and most of them connected up to pumps. It will be convenient to tabulate the exhibits in two columns.

<i>Type of engine.</i>	<i>Type of pump.</i>
Oil engines :—	Centrifugal pumps :—
1. Petrol.	1. Open impeller.
2. Kerosine oil.	2. Closed impeller.
3. Liquid fuel.	3. Self-regulating.
4. Diesel engines.	4. Multiple stage.
5. Semi-diesel.	Chain-pumps.
Gas engines :—	Norias.
Vertical.	Cornish pumps.
Horizontal.	Three-throw pumps.
Steam engines :—	
Portable.	
Semi-portable.	
Windmills.	

It is only in the Madras Presidency that mechanical methods of lift-irrigation are at all largely used by the cultivators, and my remarks on the exhibits at Allahabad are necessarily based on the experience that has been gained in the Pumping Section of the late Department of Industries.

The steam engine may be dismissed with a very few words. Even where coal is very cheap it cannot be recommended as suitable for the ryots' work. By the use of superheaters the fuel consumption has been reduced to a very low figure, but the engine requires a skilled attendant who must satisfy the requirements of the local Boiler Acts. For very small powers it is hopelessly beaten by the internal combustion engine, but for larger powers where coal is cheap, as in parts of Bengal, it is still the best type of motor that can be employed.

For agricultural purposes the type of engine which should be recommended depends largely upon the relative cost of the different kinds of fuel which can be used in internal combustion engines. Over the whole of India the price of kersoine oil varies but slightly, whilst it is only in places that a cheap supply of liquid fuel can be obtained. In the Madras Presidency liquid fuel is about half the price of kerosine oil and the consumption per brake horse-power is by volume practically the same, so that, although liquid fuel is not so clean and nice to use as kerosine oil, the large saving in cost outweighs this disadvantage and renders it desirable to employ a type of engine in which it can be used without difficulty. At one time the Diesel and the Hornsby-Ackroyd engines were the only two which were quite satisfactory to use, but since the expiry of the Ackroyd patents there are a number of engines on the market by different makers, all of which run well enough with liquid fuel. The Diesel engine is not suited for small powers and requires a skilled attendant to keep it in good running order. Its capital cost is also high, and for these reasons it may be considered out of the agricultural field. Within the last year or two English makers of oil engines have put on the market what may be termed a 'Semi-Diesel' engine, of which at

least one example was to be seen at Allahabad. It was working very smoothly and the consumption of fuel, though higher than in the Diesel engine, was much below that usually obtained in ordinary oil engines working with liquid fuel. Where a portable oil engine is required, the work is not only intermittent but generally of a special character that will bear the cost of a rather more expensive fuel, and there were exhibited several small vertical oil engines which would run on petrol or on kerosine oil if first started with petrol. Such engines invariably run at a very high speed and require to be of good design and the best possible workmanship. A cheap engine of this type is therefore not to be recommended, but if a sufficiently high price is paid, it is possible to get a really satisfactory motor. They are usually magneto fired and it is important that the magneto should be of an approved type. I have used one of these engines coupled direct to a 3-inch centrifugal pump during the last three years and found it admirably suited for testing water-supplies or any other work of a temporary character such as cleaning out temple tanks. I understand that the local conditions are such in the United Provinces that portable engines are likely to prove very useful, and I think that on the whole the light high speed type will be found better suited for this class of work than the ordinary type of oil engine mounted on a girder frame.

Where wood charcoal can be obtained at a cost not exceeding Rs. 20 per ton, gas engines and suction gas plants represent for anything over 10 h. p. the most economical of type of motive power that can be employed. There are many designs of gas engine now on the market which work extremely well and with most gas producers charcoal can be used if adequate provision is made to remove the tar which invariably comes over. Suction gas engines are now made which will work with wood, or

sawdust but they cannot well be employed for anything under 35 h.p. I have no extended experience with this type of producer, but I am satisfied that they will do all that the makers claim for them, as I have had one such plant at work, developing about 80 B. H. P. for several months.

There were several windmills exhibited at Allahabad, but owing to the lightness of the winds during the exhibition it was impossible to get them to work against any load. Where fairly strong continuous winds can be relied upon, a windmill is a very suitable type of motor for well irrigation when the lift is not more than twenty-five feet. On the West Coast of India and in the Deccan there is sufficient wind to make it worth while to put up these mills, but over the rest of India the air currents are usually too light and of too variable a character to obtain results commensurate with the capital outlay involved. It should be noted, however, that the wind velocities are usually the highest during the hot dry month of the year when water is most required.

Turning now to the various power-driven water-lifts attention may be drawn to the *norias* and chain pumps. For small lifts, and not very large volumes of water, the chain-pump appears to have a possible future in front of it, but without prolonged experience as to the life of the chain and the general wear and tear and without accurate tests as to its efficiency I am not prepared to say that it is better than a centrifugal pump. Some well-designed *norias* driven by small engines were also exhibited, but I doubt if they can hold their own either in first cost, efficiency or durability with the best modern types of centrifugal pumps. For irrigation work it is hardly necessary to consider the various types of high pressure pump, either of the reciprocating type or the multiple stage centrifugal, as it will be a long time before

agriculturists in India will be sufficiently advanced to venture to lift water from depths which will involve working against high pressures. It remains, therefore, only to consider the single stage centrifugal pumps, and of these practically every modern design was in evidence at the exhibition. It is quite beyond the range of these notes to enter into a discussion of the principles on which the various forms of this pump are designed. The efficiency of a centrifugal pump increases rapidly with increasing size, and pumps below 3" in diameter of suction pipe should ordinarily not be employed. The majority of 3" centrifugal pumps on the market have an efficiency ranging between 40 and 45 per cent. and the larger pumps have an efficiency up to 55 per cent. but during the last few years much attention has been paid to the design of centrifugal pumps, and 3 pumps can now be obtained with an efficiency of 70 per cent. and the larger sizes with an efficiency of nearly 80 per cent. These pumps are naturally more costly than the older types, but they require, for equal quantities of water delivered, a much smaller engine, and we find in Madras that it pays well to buy centrifugal pumps of the highest efficiency obtainable as the combined cost of the engine and pump is lower and the working expenses permanently less. Where the vertical lift, on which the pump works, varies considerably at different times of the year, or as often happens in wells during the course of the same day, there is a great advantage in using self-regulating pumps, and these can now be obtained to work with practically the same amount of power over a very long range of lift. This is a very important matter when internal combustion engines are used, as such engines can only be efficiently worked near their maximum load and will not stand any over-load whatever. Till the self-regulating pumps came on the market we often fitted the ordinary type

of centrifugal pumps with two fast pulleys of different diameters so that the speed of the pump could be roughly varied to suit marked changes in the height of the lift. Previous to the adoption of this practice the variations in the water-level rendered the working of centrifugal pumps extremely unsatisfactory, and in more than one instance I have known a rise in a river so increase the load thrown by the pump on to the engine as to pull it up. This may sound paradoxical, but it is well-known to those who have much experience in the working of centrifugal pumps and the difficulty has been entirely eliminated since attention was first drawn to this point in one of our reports on Irrigation by Pumping.

The exhibition of water-lifts at Allahabad demonstrates conclusively that Mechanical Engineers both in England and India are becoming alive to the fact that a great market awaits them in connection with lift-irrigation in India, and we may confidently expect that competition for business will lead to a careful study of the problems and that great improvements will ultimately result. It is a matter for regret that the recently invented Humphrey Gas Pump did not arrive in time to be shown in working order at the exhibition. It represents a revolution in our methods of generating power, but the exact range of its application can only be determined by practical experience. So far, the pumps constructed have been of a capacity much greater than will ordinarily be required in India, and it is certain that the details of the design will require to be greatly modified before it has any chance of proving a serious rival to the small pumping plants for which a very big field undoubtedly exists in India.

CHAPTER XI

ENGINEERING IN INDIA*

I

When it was first suggested to me that I should deliver an address to you this afternoon, I gladly consented, as I was conscious of the great honour conferred upon me, and I was anxious to renew my connection with the Central, which during the last seventeen and a-half years has been of a very slender character. At the time, however, I did not realize the extent of the responsibility I was thereby incurring, or the difficulty I should experience in selecting a subject for my remarks which would be appropriate to the position I am now placed in. On previous occasions you have received words of weighty advice from men whose names, throughout the world, are associated with some of the most brilliant achievements of Engineering science, and whose long and illustrious careers entitle them to address you in terms which it would be presumptuous for me to use. After some consideration, however, it seemed to me that I could only come before you as an old student of the College, who has been out in the world long enough to test the value of the training he received, first at the Finsbury Technical College, and then here, and give you some idea of what the future has in store for you

*Inaugural address to the students of the City and Guilds Central Technical College. 1905.

if any of you should be destined to find that your life's work lies in India.

It is twenty years, all but a month, since, with six or seven others, I attended the first lecture that was given in this building, and I think you are all to be congratulated on the fact that with but one exception the departments of this College still continue to be directed by the same distinguished pioneers in the cause of technical education that presided over them in the beginning. This is the first formal meeting of the students that has taken place since Professor Unwin resigned the chair of Civil and Mechanical Engineering, and I am glad to have this opportunity to express both on your behalf and as a representative of the students who have passed out of the College, the regret we feel that he should have felt it necessary to retire from active participation in the work of the College, whilst at the same time we rejoice to know that after many years spent in training young Engineers he still retains health and strength to enjoy the more ample leisure which lies before him.

The students of the Central owe a vast debt to Professor Unwin which they can in part discharge by cherishing and acting up to the same high ideals that were ever before him in all professional matters. His work extended far beyond the walls of this Institution, and all over the world Engineers have benefited enormously by his labours in those branches of scientific Engineering which he made more particularly his own. I am just old enough to remember how great a part he took in working out the courses of instruction and methods of training which are followed in nearly every English-speaking Engineering College at the present day, and all of you must be acquainted with those well-known volumes on Machine Design which have done so much

to take the work of the draughtsman out of the region of pocket books, empirical formulæ, and rule of thumb experience, and place it on a definite scientific basis. In *Hydraulics*, the article which he contributed to the ninth edition of the *Encyclopædia Britannica*, notwithstanding its necessarily extreme condensation, has attained the remarkable position of becoming the standard English work on that branch of Engineering.

There are other well-known books which he has written to which attention might be drawn but I refrain that I may remind you that before Professor Unwin came to this College, more than twenty years ago, he had been Professor of Hydraulic Engineering at the Royal Indian Engineering College at Cooper's Hill, and in that capacity he was largely responsible for the training of the men who now occupy all the senior Engineering appointments of the Indian Public Works Department. India has been the scene of many great Engineering exploits and in these Professor Unwin's students have borne a distinguished part, and upon them at the present moment rests the responsibility of preparing the great programmes of future work which are the outcome of the strenuous labours of our most sagacious and distinguished viceroy. I am personally acquainted with a great many of these Cooper's Hill men, and I know that they hold Professor Unwin in the same high esteem that we do.

When Professor Unwin went to Cooper's Hill in the early seventies, the methods by which men became Engineers were widely different from what they are to-day. Engineering education had usually to be picked up in the workshops and drawing office in a hap-hazard kind of way, and the facilities for acquiring a thorough knowledge of the scientific principles underlying the practice of the

profession were of a very limited character. For years previously the Government of India had experienced considerable difficulty in enlisting a sufficient number of engineers with the qualifications essential for a successful career in the East. When, therefore, it was determined to adopt a vigorous policy in respect to Public Works, which it was easy to foresee would require large additions to the engineering staff, the establishment of a special College for training young men for the Indian Public Works Department was sanctioned. From the very outset the scheme was a great success, the College filled up with students from the public schools, and after a three years' course they were sent out to India, where they proved themselves well qualified to maintain the high traditions of English administrative efficiency which have been established in India.

Times however changed, and in recent years the Government have been unable to offer appointments to all the successful students of each year, so that gradually it came to be thought somewhat anomalous to maintain a State College at considerable expense for the training of men who could easily be obtained from the Engineering Institutions of University rank which had been founded later than Cooper's Hill.

Though the original *raison d'etre* for its existence had disappeared, the College did its work so well that every one was loth to disturb it. Only when the question of funds to bring it in line with modern requirements became acute was the necessity for the College itself challenged. In face of the provision which has been made in recent years throughout the British Empire for the special training of engineers, there could be but one result of the enquiry, and the decree has gone forth that the College should cease to exist. Henceforth the Government

of India will recruit its engineering service with men trained in possibly any part of the King's dominions ; and from the wider field that may be drawn upon—from the more varied experience of the men selected—it is not unreasonable to expect that great advantage will accrue to India ; but that advantage would be worth little if it were purchased at any sacrifice of the splendid heritage that the Cooper's Hill men have created in the way of *esprit de corps*, a high standard of professional honour and self sacrificing devotion to the public service.

So far the Central Technical College has not sent many men to India, but under the new conditions it is not improbable that some of you here to-day may find employment there, in the not very distant future, either in the service of Government or in the prosecution of private enterprises, which it is the policy of the Government of India to actively encourage.

India entails a great responsibility upon the British people, yet it is one that the average man bears lightly enough and perhaps rightly considers that his duty is done when he assures himself that the administration of that great Empire is entrusted to statesmen of high probity and great skill, with the expert knowledge essential for the government of so many millions of people who live under conditions so very different from those that prevail here. It is not a little to the glory of Englishmen that India has never been a subject for political discussion, and that all parties have ever been united in agreeing that Indian problems must be dealt with in a calm, judicious manner by men who are fully qualified by special experience and training to deal with them. It was, I think, Lord Curzon who declared that to the possession of India the British Empire largely owes its present greatness and commanding position in the eyes of the rest of the

world. This being so it is certainly desirable that you, who in the future are destined to be among the leaders of industrial enterprise should take an intelligent interest in the material development of the country. It therefore requires no apology from me, if I direct your attention to that great Eastern dependency and briefly discuss some of the industrial questions which come before us out there, and which we hope to solve by the application of technical knowledge and skill such as you are acquiring here.

Compared with European countries, India is extremely poor ; but were it not for the periodical visitations of famine, caused by severe droughts over large and thickly populated tracts, the pinch of poverty would seldom be felt. The tilling of the soil is the occupation of the great bulk of the people, and, where there is sufficient moisture, the earth yields a generous harvest. The people lead simple lives, and, if their worldly possessions are few, their wants are fewer. Even in the worst years there is enough food for all grown in the country, and the difficulty of transporting it to the famine stricken districts has been met by the construction of a very extended system of railways ; but the problem of finding work for the millions thrown out of employment by the enforced cessation of agricultural operations has not yet been satisfactorily solved.

In the towns the artisan classes, who look to the indigenous industries of the country for a means of livelihood, are in a less satisfactory condition than the agriculturists. To a large extent these industries have suffered from the competition of imported goods produced in modern mills and factories with labour-saving machinery of the highest type. Without much enterprise, unaided by capitalists, incapable of adapting themselves to the changes in their environment, and wedded to their antiquated, hereditary

methods of working, the artisans have had no resource but to sell their labour at lower and lower rates, till at last a limit has been reached, and they can part with the productions of their labour at no lower price without risk of starvation. It must not be imagined that the Government of the country have stood callously by, heedless of the way in which the people are being ground down by the operation of economic forces beyond their comprehension and control. Not much, indeed, has been done, for the resources of Government are limited, and it is only quite recently that the higher and more intelligent castes have began to take an interest in industrial questions.

There is not the slightest reason to doubt that India is steadily growing richer, but the wealth is flowing into new channels, and, during the long period which must necessarily elapse while the people are being prepared to face the changed order of things, it is unavoidable that much suffering should be experienced by those who are weakest and least capable of helping themselves.

During many centuries war, pestilence, and famine prevailed through the land, and sternly checked the too rapid growth of the population. For nearly half a century there has been uninterrupted peace: sanitation has made enormous strides; and though we have not yet made much headway against the ravages of bubonic plague, it is held in check, and the mortality from epidemic diseases has greatly decreased. People do not now die by millions from actual starvation, thanks to the splendid system of famine relief which has been devised to meet the failure of the harvests when the rains hold off. This is a record of which any administration may be proud, but it has resulted in an alarmingly rapid increase in the population, which presages terrible calamities in the future unless adequate measures are taken in time by a far-seeing Government to ward them off.

The opinion is generally held that India is a country with vast undeveloped natural resources. To some extent this is true, but not in the sense that the same statement would imply when made of the United States and Canada. They are new countries with great mineral wealth, vast water powers, and huge tracts of rich land yet unoccupied. India is an old country, which for many centuries has supported a teeming population, and all its good land has been occupied for countless generations. It possesses some mineral wealth, but it is too diffuse to be easily garnered, and its stores of precious metals which probably exist are buried beneath the debris of workings carried on in a dim past. The soil is in the possession of small farmers or ryots, who are devoid of ambition, and content if only they can procure their daily bread at the least possible exertion to themselves. In some places they are good agriculturists, who make the most of their limited resources, but generally they are backward and ignorant ; the land does not yield to them what it might be made to do under better treatment. Where water is difficult to obtain it is generally used with intelligence and skill ; where it is abundant and costs little or no labour to apply to the land, there it is wasted on crops which are easy to cultivate but, in consequence, of little value. In favoured localities the ryots are wealthy, but this wealth is hoarded in the form of jewels and gold coins, and is literally buried in the ground inside their houses instead of being usefully expended on the improvement of their fields. No man trusts his neighbour, and seldom his brother, co-operation to secure a common end has proved a failure, and joint enterprise is almost non-existent. In face of these difficulties something has to be done, and men are wanted with perseverance and tact to steadily overcome the ignorance and prejudice which are such fatal barriers to any progress.

In the aggregate, the modern industrial enterprises of India are by no means insignificant ; but, in comparison with the extent of the country, the number of the population, and the value of the raw material produced, they are surprisingly small. The cotton mills and weaving sheds of Bombay, the jute mills of Bengal, and the tanneries and leather works of Cawnpore may be cited as well-established industries. The gold mines of Mysore and the coal mines of Bengal, especially the latter, are of immense value and increasing importance. The railways have large locomotive repair shops and carriage building works scattered about the country, and there are a few private engineering shops, but the iron trade is represented by only one establishment, which, after many vicissitudes, seems to have now entered upon an era of prosperity and development. Of miscellaneous industrial undertakings, there are not a few ; but they are widely scattered and of little importance. For military reasons, it is considered desirable to render India independent of England in the matter of equipment ; and the arsenals, factories, and workshops which have been established to carry out this policy, employ many skilled artisans, and are of some importance as centres from which technical knowledge is gradually spreading.

The extremely rapid progress which in recent years has been made in the transmission of energy through long distances by alternating currents of electricity, and the continual expansion of the field for its employment, not only for electric lighting and power but also in electro-chemical and electro-metallurgical industries, has given to possible sources of water-power a high potential value. In India, the available power is considerable, but it is badly situated, and it is difficult to make any profitable use of it. Something, however, has been done, and the water-power

plants which have been installed total up to quite a respectable figure.

You may possibly think that this brief review of the condition of India is not very inviting, and that I have painted a rather gloomy picture. Perhaps so, but my object is not to tell you of what has been done, so much as to point out how much remains to be done, and what a splendid field exists for men with technical knowledge to devote their energy and ability to overcoming the difficulties which the geological structure of the land, the meteorological conditions of the atmosphere, and the social peculiarities of the people place in the way of those entrusted with the material development of that country.

Service in India is not without serious drawbacks, but the advantages are great, and not the least of these, to any one of an enthusiastic temperament, are the many opportunities for beneficent work. The Government of India, with wise liberality, pays its servants well, is generous in the matter of furlough and leave, provides an adequate allowance when the time comes for retirement, and, in return, expects strict integrity, single-mindedness of purpose, and whole-hearted attention to duty. More than this cannot be asked from any body of men, but more is often rendered, and there are not a few who recognise that behind the Government are the people of India on whose behalf all are working, and the interests and welfare of these dumb millions appeal to them with the same force and the same earnestness as do the spiritual needs of these great masses to those self-sacrificing men and women who, from the Christian nations of the world, go forth, without hope of earthly reward, to labour amongst them in the best interests of the human race.

The work of Englishmen in India is daily increasing in difficulty, and will continue to do so as a natural result

of our efforts to ameliorate the condition of the people. Education is spreading, and its foundations are becoming broader and deeper, and, as the final product improves, a larger share of the administration will be claimed and conceded. But a leaven of Englishmen will always be required to preserve the present high standard of service, and it is difficult to even imagine the time when the direction of affairs will pass out of our hands. Our numbers may decrease, but we shall have to give of our best to India if we are to successfully continue the work that has been so well begun. Especially is this true in those fields of activity with which we are more especially concerned, though the reasons for it being so are somewhat different. Nearly all the obviously possible work has been done, and ahead of us are nebulous schemes of great magnitude which will require the application of great engineering skill to reduce to the region of practical projects.

In this work, native assistance will be gladly welcomed, and provision has been made to render it available as far as may be possible. There are in India four Engineering Colleges, whose equipment compares not unfavourably with that of similar institutions in Europe, and provision has been made to give instruction similar in character to that which you receive here. The results within the last few years have been eminently satisfactory, and it seems not unlikely that India will again produce engineers, to whose works future generations will accord the admiration we now ungrudgingly bestow on the constructors of the irrigation tanks of Southern India, or of those magnificent buildings and archæological remains in Northern India; of which I need only cite the Kutub at Delhi and the Taj at Agra as examples, the one dating from the beginning and the others from near the end of a long period of steady progress in civilized arts.

The men who go to India must be prepared to devote themselves to the pressing necessities of the moment. It is no place at present for learned leisure or abstract scientific research. Engineering, chemical, and physical laboratories have been provided for the training of students, and facilities exist for the prosecution of researches. The work, however, should have a practical bearing on the development of the country, and for my own part I can see no reason why, because it has an immediate economic value, it should be less worthily of regard in other respects. The advancement of knowledge, deep probing into the mysteries of nature, the carrying on of investigations for their own sake and without regard to their utility,—these are all fascinating pursuits, which rich countries can afford to pay for, but the Englishmen, who go to India, go there to administer to her needs and to devote their attention to the work which must be done on the spot. What are wanted in India are men who will carry there a knowledge of what is being done elsewhere and will turn that knowledge to useful account. Indian engineers and Indian engineering are much better known in England than was formerly the case, but even now it is given to few men, who spend there lives in India, to achieve a reputation which extends beyond the jurisdiction of the Viceroy ; yet their work meets with generous recognition in India and by none more than by the people themselves, who are keen to distinguish and appreciate the services of those who are labouring for their advancement. Undoubtedly the greatest monument of English engineering skill in India is not her system of railways, magnificent though they be and remarkable for the economy and safety with which they are worked, but the vast network of canals and channels which distribute water to the fields and enable rich crops to be grown on what where former-

ly barren wastes. The irrigated area to-day is equal in extent to the whole of Great Britain, and almost every year a tract of land that would make a fair-sized English country is added to it. In all the rest of the world there is not more than half as much again.

Do not suppose, however, that we claim all the credit for this great work. The Dravidian Kings of the South built Tanks whilst this land was under Druidical domination, and the engineers of the Mogul emperors dug canals from the Jumna that were the precursors of our later works. Yet we must not give these ancient men too much credit—there was not much science but a good deal of brute force in their methods of procedure, and it is inconceivable that under any circumstances their systems of irrigation could have ever advanced beyond the primitive stage in which we found them.

Sixty years ago, Sir Arthur Cotton completed the works necessary to restore prosperity to the Cauvery Delta, and fully fifty years have elapsed since the Upper Ganges Canal, due to the genius of Sir Probyn Cautley, secured the Gangetic Doab from seasons of scarcity and drought. From that time onwards, irrigation has steadily progressed, though not so rapidly as some would have us think is desirable in the best interests of the country; and when the ancient land of Egypt came under British influence, it was to India that Lord Cromer turned for engineers to deal with the deplorable state of affairs which he found there. How well they responded to his call, the whole world knows, and the reputation of Indian engineers has greatly risen in consequence of what a few of them have been able to do there under circumstances of great difficulty, and in sight of all the politicians of Europe.

It is not my purpose to attempt even the briefest description of irrigation in India, but I would like to invite

your interest for a few minutes in the problems which have to be tackled in the future, and which some of you may perchance have to do with. Two or three years ago the irrigation of India was thoroughly reviewed by a special commission, who issued a report indicating clearly the policy which should be pursued with regard to future extensions of irrigation, and they recommended an expenditure of over £30,000,000 in the course of the next 20 years. India wants water for irrigation above all things ; the water is there in ample abundance, but it is not where it is wanted, nor is it always available when it is wanted. So far, all Indian irrigation works which we have constructed are gravity schemes, which take the water from the rivers and, by carefully graded systems of canals, convey it to land at a lower level than the intake. In some cases, the canals are combined with storage works to tide over fluctuations in flow of the rivers, and in other cases the reservoirs impound the whole flow of considerable drainage areas, and hold it in reserve till required.

But nearly one-third of the irrigated lands of India are watered in a totally different way. The water is below the surface of the ground and has to be raised above it. Millions of wells have been sunk to tap the subterranean supplies, and it has been estimated by the Indian Irrigation Commission that every year one billion cubic feet of water are thus obtained. The amount of work that has to be done is very large, and it is all performed by animal or human-labour. I calculate that if this work is done in 120 days, of 8 hours each, the rate of doing work during that time is not less than one and one-third million horse-power, and that about four million pairs of cattle are employed. There is a great deal yet to be done, especially in the Punjab, with gravitation schemes, but, in the main,

future extensions of irrigation will be dependent on either the construction of huge reservoirs of the type of that which has recently been formed in the Nile valley by the construction of the Assuan Dam, or on an increase in the water supply derived from flowing rivers by raising the water with powerful pumps, or upon a large increase in both the number of wells and the quantity of water which is derived from each individual well.

For some years past it has fallen to my lot to be associated with the enquiries and investigations that have been going on regarding the possibilities of developing irrigation with well water, and I am inclined to think that there is more hope in this direction, than in any other, of obtaining the water so much needed to enable the future of India to be faced with equanimity.

Till quite recently it was commonly accepted by engineers that engines and pumps could not compete with the indigenous methods of raising water from wells in India, partly because the units of supply were too small to deal with, and partly because cattle could do the work at absolutely no monetary cost at all to the ryots. Oil engines have now given us a simple and cheap source of power in small units, and a study of the water supply to Indian wells has enabled improvements to be effected which have greatly increased the yield and demonstrated beyond question that, in certain instances at any rate, modern methods of lifting water may be profitably employed in India.

We are, as yet, but in the initial stages of the work, and have only advanced far enough to realize all the troubles that lie before us in trying to effect on a large scale what has been accomplished in a few instances under special circumstances. The problem of lifting water from a well is apparently a very simple one, but if it is to be done by mechanical means in tens or hundreds of

thousands of instances in India, not only every item of the plant will have to be subjected to rigid scrutiny with a view to improvement of details but it will also be necessary to go back to first principles again and examine the possibilities of development along mechanical lines which have hitherto been neglected. To begin with, the centrifugal pump is not a model of efficiency, and we look for the evolution of an irrigation pump which will be a great advance on what may be termed the contractor's pump, which, hitherto, has been most widely employed. A more efficient pump means a smaller motor, less capital outlay thereon, reduced working expenses, and, to obtain that, it may be made in a more costly way, provided its certainty of action and freedom from breakdown is not in any way compromised. Again, the oil engine is a very good motor, but it has not yet reached finality, and every improvement that can be effected in it increases the sphere in which it can be usefully employed. Even in such a comparatively simple matter as belting, the irrigation engineer is far from satisfied and would be glad to find a more durable material.

Next to India, there is more irrigation in the United States of America than in any other country in the world, and quite recently I was deputed to visit some of the States to see what progress has been made in methods of lifting water. I found that where the conditions were favourable great things had been accomplished, particularly in the States of California, Louisiana, and Texas. In the irrigated orchards of California, especially in the citrus fruit-growing districts of the South, water is of immense value, and there has, in consequence, been perfected a system of irrigation which surpasses anything that has been done elsewhere. The water is lifted as much as 150 feet from wells of great depth by centrifugal pumps, driven

by three-phase alternating current induction motors, and the power is supplied from generating stations driven by water in the distant canyons of the Sierras. To avoid loss by percolation the water is conveyed to the land in concrete pipes and distributed through the orchards in concrete channels, and in extreme cases pipes, buried in the subsoil, carry the water to the roots of the trees, so that from the time it is raised from the well till it is absorbed by the trees it is never once exposed to the open air and evaporation losses are entirely eliminated. In some places I found compressed air was in use for lifting water from deep wells with very satisfactory results, for though the efficiency of the method is generally less than 30 per cent., yet the amount of supervision required is extremely small. Wages in California are very high and liquid fuel is very cheap in the oil regions, so that a process, which is extravagant elsewhere, becomes economical under these unusual conditions. We cannot copy Californian irrigation practice in India with any hope of success, but there seems to me to be no reason why we should not profit by the experience of rice cultivation in the Gulf States of Louisiana and Texas. There, within a very few years, 600,000 acres have been brought under irrigation with water raised from the bayous and swamps which extend along the sea-coast to the West of the Mississippi delta. The lift varies considerably, up to a maximum of 72 feet, and is generally much greater than anything we have supposed to be practicable in India.

In the United States there are hundreds of thousands, if not millions, of windmills in use for pumping water for domestic purposes, for watering stock, and for the cultivation of small vegetable gardens or patches of alfalfa, but only in certain tracts are they largely used for lifting water for irrigation. Where the winds are regular and of suffi-

cient strength, as in Nebraska and Kansas, they have proved satisfactory. The windmill which will automatically vary its load to suit the force of the wind has yet to be designed, but when that very difficult feat has been accomplished there seems to be a great future for windmills in irrigation work, and in certain parts of India, in the Deccan and along the Peninsular coasts, it is likely that they may be used with advantage.

Very closely connected with irrigation questions in India is the improvement of agriculture, and in that direction much requires to be done to induce the ryots to alter their ways and by more intelligent labour cause the soil to yield a better return. A great college of agriculture with laboratories and experimental farms has recently been established at Pusa, but it will probably take a long time for the work done there to permeate downwards and to become the established practice of the ryot. The capitalist cannot find profitable employment for his money in the extension of well irrigation unless a system of intense cultivation is introduced at the same time. The average value of crops in India is small—not more than 30s. or 35s. per acre for dry crops and perhaps double that amount for wet. With an average lift of 30 feet the cost of irrigation by pumping would amount to about £1 per acre, and it is therefore obvious that the crops as ordinarily grown will not pay. Crops such as sugar cane, plantains, ginger, turmeric, sweet potatoes, &c., will yield returns of from £10 to £35 per acre, and it is to the extension of this sort of cultivation that we must look for relieving the pressure on the soil. The returns from these crops are large, and, though the expenses of cultivation are heavy, they ultimately resolve themselves mainly into labour charges—even in the case of manure unless it be imported from abroad.

It is crops which are on the ground all through the year which yield the greatest return and it is from wells that we can obtain the most reliable continuous supplies of water. A permanent flow of one cubic foot per second is worth from 6 to 8 times as much as when it is available only for six months in the year. Hence it is desirable that engineers should turn their attention to securing water for irrigation at all times in the year, and not merely during the monsoon months and immediately after them. Storage works are one way of doing this, but the losses from evaporation and percolation are so very considerable, when the water has to be held up to last right through the dry weather, that it is seldom sufficiently favourable sites can be found to render the outlay on them remunerative. Pumping from river beds and subterranean reservoirs is likely to prove feasible and where the water is utilized to the best advantage it will certainly prove profitable. Sugar-cane is largely grown in India, but the quantity is insufficient for the needs of the people and more than £10,000 a day is paid for imported sugar which might easily be grown in the country. Between 17 and 18 million acres are devoted to the cultivation of cotton, but the value of the crops does not exceed £1 per acre, whilst in Egypt it is worth 14 times as much. The conditions are vastly different, but I believe it is within the powers of the engineer and the scientific agriculturist to reduce the inequality to some extent. If the Indian cotton crop averaged per acre but one quarter what it does in Egypt, India would be enormously benefitted and the troubles of the Lancashire cotton spinners would be indefinitely postponed.

In India the people hoard money, from the Prince upon his gadi to the ryot in his fields—it is a relic of by-gone days when might was right—the necessity has

passed away but the habit remains ; yet not entirely so, as good land is freely purchased and the demand for first-class irrigated land in favoured situations has forced values up to extravagant figures. A great deal of barren land can be made as productive as the best by the free expenditure of capital, and our scientific and engineering skill should be devoted to demonstrating this ; not in one place or two, but in many. Then the native land-holders and men of wealth will follow suit. They have at their command more than sufficient capital and, if we could gradually get them to spend it on the land, who can doubt but that marvellous changes would be effected ?

One is generally told that India wants water and that in the extension of irrigation is to be found the remedy for her poverty and its concomitant train of evils. That is only partly the truth : India not only wants water, but wants to be taught to utilise it to the best advantage. America has shown what can be done in this direction and we might with advantage follow some of her methods. They ryots it is true are very conservative but they are also very much alive to their own interests when they understand them—it is for us to point out to them the direction in which they can do best for themselves.

The future welfare of India depends mainly upon our being able to provide for a more rapid rate of increase in the powers of production of her people than the rate of increase of the people themselves, and that, not only among certain sections of the community, but generally throughout the whole mass of the population. The substitution of machinery of human or animal labour is an important step in this direction, and should be carefully fostered. Well cultivation would probably extend much more rapidly than it has done, were it not dependent upon cattle for lifting the water. Under present conditions,

the area so cultivated is the maximum possible, and without some external source of power it can only grow slowly. Double the amount of power at the disposal of the ryot, and you will enormously increase the area of land supplied with water. The ryot really pays a great deal for the work done for him by his beasts, but he has not enough intelligence or sufficient knowledge to appreciate the fact. With his own cattle he can irrigate a certain amount of land : if he attempts to hire cattle to extend the area, his methods of cultivation do not return him sufficient to make the venture profitable. In almost every part of the country we can supply him with power for lifting water—either by steam engines, oil engines, or electric motors—at not more than half the rates he really pays for cattle. Induce him to cultivate more valuable crops ; induce a flow of capital to the land to enable this to be done ; with part of this furnish the necessary motive power, and the result will be a satisfactory return on the total outlay. That this is no mere theory I could easily show, by giving you details of what has actually been accomplished, but time does not permit.

Owing to the concentration of the rainfall into certain months of the year, the water power of India fluctuates through extreme limits, and storage works will be necessary to render any very large quantity available throughout the year. Fortunately, the cost of such storage works can be partly recouped from the returns which the irrigation under them will yield, but, unfortunately, there is practically no use to which water power can be put in India. The great industrial centres, Bombay, Calcutta, Madras, Cawnpore, Lucknow, Delhi, and other towns, would be immensely benefitted by a supply of electric energy at low rates, but they are all too far away from any source of supply

which will not fail for months in every year. Electric light is too great a luxury for the country, and the water power that has so far been turned to good account has been made use of because of exceptional conditions. Every year, however, prospects in this direction are improving, and, once in five years at least, it is worth while re-examining the water power schemes to see if electrical developments have brought them within the range of commercial possibility. As I have already mentioned, electricity generated by water power is largely used in California for pumping water for irrigation, and it is merely a question of time before it will be similarly used in India. Provide water for irrigation all the year round, and you will have water power also available. By means of electricity this power can be used for raising further supplies of water, and the area of intense cultivation can be further extended.

To turn to another direction, a report recently prepared for the Government of the Dominion of Canada brings forcibly to our notice the progress that has been made in what may be termed the electro-thermic production of iron and steel. In the South of India especially there are valuable deposits of iron ore, extensive forests capable of yielding considerable supplies of excellent charcoal and water power, which can easily be converted into electric energy. Here are all the requisites for electro-thermic iron and steel works on a great scale, and in India there is a market for the products. If the process is practicable, Canada will probably give us a lead which we shall do well to follow with as little delay as possible. India cannot afford to be the pioneer in such matters, but as early as may be, she should be placed in a position to take advantage of new discoveries.

Excluding the telegraph, electricity plays no part in the life of people save in the capital cities and a few big

towns. Many schemes are under discussion, and in the near future there is likely to be something done, but even as it is useless to patch a threadbare garment with new cloth, so it is absurd to think that electricity can be usefully employed in India on a large scale, till great changes have been effected in ways and thoughts of its inhabitants, and a new race evolved. The spread of education is gradually bringing this about, but progress is slow, much slower than is generally acknowledged. The Parsees in Bombay, and the Europeans in Calcutta and elsewhere, are mainly responsible for the modern industrial enterprise which is credited to India. In reality, the Hindus and Mahomedans have done very little, and their constantly reiterated cry for Technical Education may be taken as evidence that they themselves, in a dim kind of way, perceive how little share they are taking in the regeneration of their own country. The system of education we have given to India has produced excellent government officials, good lawyers, and fair traders, but it has not turned out manufacturers or men capable of re-organizing the artisan labour around them on a new basis—on one which would enable it to withstand the pressure of external competition.

Attempts are now being made to remedy the evils that this unilateral system of education must be held responsible for, and technical skill and knowledge of a high order will be required to carry out the policy of reform which is gradually forcing itself upon Indian Administrators. Many experiments have been made, and in some instances success has been attained, and it is now fairly definitely settled that the Government may with perfect propriety take active measures to establish the industries of the country on a better footing. Encouragement is to be given to private enterprise, new industries are to

be exploited, and the technical assistance placed at the disposal of those who need it and are not yet in a position to provide it for themselves.

England and India face the world as free traders, the former a great manufacturing country, importing mainly raw materials and food-stuffs ; the latter an agricultural country, exporting raw materials and importing manufactured articles. The tariff walls of protectionist countries preclude India from hoping to find a market outside the British Isles for her manufactures, and compel those who would promote industries to confine their efforts to producing what can be sold in the country itself. The internal demand depends almost entirely upon the state of agriculture, and fluctuates with the varying nature of the seasons. Hence, the improvement of agriculture is an essential preliminary to industrial expansion.

Hand labour in India has failed in competition with machinery, not because the labourer demanded much for his hire, but because he offered little as the results of it. There is no virtue in hand-work when the same can be better done by machinery, and no reason for resisting the introduction of such machinery, but rather otherwise, since it is desirable that the hand-worker should be relieved of drudgery as much as possible and taught to concentrate his attention on the production of what is beyond the range of machinery. This is the direction in which the most can be made of the cheap hand labour of India, and, for a beginning, we must educate the artisans in modern methods, tools, and processes of working, demonstrate the necessity for co-operation and the advantages of the sub-division of labour, and finally put them in the way of getting the necessary capital for associated working on favourable terms.

The Indian workman is, to a large extent, what his

previous training has made him. As a rule he makes good use of his chances, possesses considerable inherited aptitude, and under proper supervision he works well and cheaply.

The hand weavers are by far the most numerous section of the artisans and at the same time the most in need of help. They number upwards of ten millions throughout the country, and when trade is normal they are probably able to keep from two million looms at work. They are greatly in need of assistance, but how to help them is the difficulty. The European hand-loom has been introduced, but as yet it has not found favour. The native warp is good enough for the native loom, but a stronger warp of more even tension is required for the fly shuttle slay, and it is not easy to supply this without getting involved in methods of working which are only suited to power factories. Hitherto native industries have been left very much to themselves, and it remains to be seen what will be the effect of subjecting them to careful scrutiny by technical experts.

Primitive simplicity is picturesque but it is not productive, and it should not be beyond our power to improve the native hand industries by introducing better tools, more efficient, even if more complicated methods, and a more varied supply of materials. But above all, native industries require business men to run them, to finance them, to advertise them, and to find markets for them. All the talent of the mercantile community is devoted to the export of raw produce and the sale of manufactured imports—local manufactures are too insignificant to interest any one and in consequence have sunk into decadence.

This picture of one side of industrial India only comes prominently into view out of India once in ten years

when the census returns furnish definite information as to the progress of communities and sections of communities devoted to particular industries. The indigenous trades and the village industries may flourish or perish without serious effect on the sea-borne trade, yet they are of vital importance to the people of the country, and indirectly they are a measure of the whole motion of the people whether it be forward or retrograde.

What I think struck me most during my recent visit to the United States was the immense amount of investigation and experimental work going on. I believe that this is so in every branch of engineering, but my attention was mainly devoted to matters pertaining to the utilization of water power, to irrigation and to agriculture. Nowhere in the world is so much left to private enterprise, and nowhere has private enterprise a freer hand. But the individual requires data to base his calculations upon, and to supply these is the recognized work of Government Departments and Public Institutions. The Federal Departments of Agriculture and Geology have a large staff of men engaged in investigations all over the Union, and the results which they obtain are regularly published in convenient form and can be obtained by any one who thinks that they may be of use to him. In the engineering schools and colleges students are well trained in making measurements, and they leave these Institutions fully imbued with the idea that in practical work nothing should be taken for granted, and that every detail should be subjected to test and scrutiny before it is accepted in a general scheme. I cannot help thinking that we want more of that spirit infused into our work in India. We are apt there to be a little too cautious, and to rely upon the West too much in matters about which we ought to make our own special enquiries. New

ideas, new process, new inventions come to us, but they are received with some degree of timidity, whereas in the States they are welcomed, examined, and adopted with confidence if they pass the skilfully devised tests to which they are subjected.

There have been a good many failures in India from the absence of this spirit of enquiry ; much that might have been done remains undone from excess of caution and a well meant intention to avoid possible waste of either private or public money. It seems to me desirable that in these matters we should change our ideas; if we do so, we may have to record more failures, but I am certain that we shall also have more successes placed to our credit. One success will often pay for many failures, because the failures will be on a small scale, whilst the successes can be developed to the utmost extent possible.

Indian engineers have a splendid record behind them, to which the irrigation works and the railway systems testify, and they have obtained brilliant results in the face of great natural obstacles, but many of them in the future will have to face the competition of the rest of the world in their attempts to give to the country its due share of manufacturing capacity. In this struggle nothing can be neglected, and if, as I hope, not a few students from this College will be found taking part in it I would advise you to make the most of the opportunities you now enjoy. But this last remark applies to you all. In the friendly struggle to be leaders in the world's progress our kinsmen across the Atlantic, in both Canada and the United States, are making great efforts, and it behoves you to display the same keenness for the honour of the country to which we belong.

CHAPTER XII

A RETROSPECT *

It was in July, 1888, just a year after leaving the Central, that I joined the Madras Educational Service as Professor of Engineering in the College of Engineering at Madras. At that time, and in fact till about seven years ago, the Public Works Department was entirely recruited in England from the Royal Indian Engineering College at Cooper's Hill, so that students from other colleges could only get employment in the railways, the municipal and local fund service, the harbour boards, or in private work. The field open was no doubt a large one, but the plums were reserved, and naturally Central men only occasionally found their way out to India. The abolition of Cooper's Hill has, however, changed all this, and the present number of THE CENTRAL will convey some idea of the part which we are now taking in the work of developing the natural resources of a country in which one-fifth of the human race are living. It is still, however, the day of small things for Central men in India, and I take it that one of the objects of this special number of our journal is to draw the attention of both past and present students to the nature of the work which engineers have done, are doing, and are preparing to do in our great Eastern dependency. It would, I am afraid, extend my contribution far beyond the limits assigned to me if I were to

* From "The Central" 1911.

attempt even briefly to discuss Indian engineering from this broad standpoint, and I only propose to illustrate the extent to which India has need for British engineers by stating that at the present time upwards of 550 members of the Institution of Civil Engineers and about 250 members of the Institution of Mechanical Engineers are resident in the country. Obviously, therefore, there is room for a very large number of men from the Central to take up and carry on the high traditions and lofty ideals so worthily maintained by the Cooper's Hill engineers.

As the pioneer of the Central contingent, I have been asked to indicate in a general way what appear to be the more important changes which have been brought about in India since I landed there a little more than 22 years ago. This is a somewhat difficult task, and would doubtless be much better performed by one who could survey the whole field of action from a distance. Nearly the whole of my service has been spent in the South of India, and for much of the time on work of a highly controversial nature, which has left me but little leisure to take stock of what others are doing, and only in the Madras Presidency have I been able to observe at first hand the effect of the great wave of unrest which has in recent years swept over the land. The educational policy initiated by Lord Macaulay in his famous minute of 1837 is now beginning to bear fruit, and last year, for the first time in history, the people of India were allowed to exercise a distinct voice in the management of their internal affairs. The prudence and moderation displayed at the first meetings of the elected councils is a happy augury for the future of India, and evidence that the much maligned system of education has not altogether failed to produce men of character and ability. That our educational policy has been only a partial success, that on its technical side we have done

very little, is largely due to the characteristics of the people themselves. English engineers have achieved some of their greatest triumphs in India, but they have not yet succeeded in producing from among the natives of the country more than a very small number of men capable of following in their footsteps. The truth is, that they do not possess in any very large measure the grit and common sense which mark the engineer, and it is fairly certain that if they did possess these qualities they would not want our assistance to maintain peace and order. When India can do her own engineering work and carry on her own industries, then, and then only, she will be able to govern herself, and our dominion, in its existing form at any rate, will come to an end. With the gradual development of local self-government there will assuredly be a corresponding development of engineering skill and a gradually decreasing demand for external assistance. The progress in one direction will measure the progress in the other, and viewing each separately at the present time, there is but little to show that India can dispense with our assistance either in administrative or purely engineering matters.

For the lower grades of professional work there is, however, no longer any need for Europeans, and even in all but the highest ranks of the service it will be well for young Englishmen, looking to India for a possible career, to remember that they will have to meet the competition of an ever increasing number of well trained and experienced Indian engineers, and that only men of great energy and considerable intellectual capacity are really required. It is a recognised principle in the administration that what the people can do for themselves they should be allowed to do, and men are only sent out to India to supply what cannot, as yet, be obtained from the country itself. Year by year the

lot of Englishmen in India is becoming more strenuous, the problems they have to tackle more complicated, and the need for ability of a high order more apparent. The importance of attracting the best men for service in the East is fully recognised, and in no branch more than that of engineering, if we may judge by the very material improvements which have of late been made in the terms under which recruitment for the Public Works Department is made. In the last twenty years the importance of thoroughly trained and highly efficient technical assistance has been more fully recognised than was formerly the case, and the gap between the covenanted and uncovenanted branches of the civil service has materially decreased. In process of time it will probably altogether vanish when the work which will fall to Englishmen in India will throughout be that which can only be performed by the most capable men the British Empire can produce.

The public services attract the best men in India and it would be altogether erroneous to assume that the very marked improvement in the efficiency and morale of the natives employed in the administration is general throughout the country. Progress there is, but it is at a very much slower rate, and must continue so for lack of men working among the people imbued with the high ideals which govern the conduct of the European officials. The schools and colleges are turning out year by year shoals of educated men, who find increasing difficulty in obtaining employment for their trained faculties. Naturally they are discontended with their lot, and inclined to blame the Government for their unhappy condition. One of the great problems which faces us in the future is to provide suitable employment for this growing class by establishing an industrial system, suited to the environment in which these people live, and adapted to their somewhat limited capacity for organisation and

control. The education they have received has unfitted them for the narrow range of rural life, but has not been sufficient to enable them to cope with the obstacles which confront them directly they attempt to carve out a way for themselves. On the one side they are faced with a vast, helpless, unorganised indigenous industrial population ; on the other, with a complex European mercantile and industrial system ; whilst in front of them is a fully occupied soil offering no scope for their puny efforts. By co-operation much might be done, but associated effort is a plant of tender growth in the East, and will require much careful watching on the part of a paternal Government to bring it to a vigorous, healthy life.

For more than a century India has enjoyed the advantages of a strong and resolute administration, devoted to the task of restoring order and prosperity throughout the land, and none can say that it has not achieved a signal degree of success. Since the suppression of the Mutiny, the last and greatest effort of the lawless forces which still slumber beneath the surface, much has been done to improve the material condition of the population, chiefly, by the construction of railways, which have rendered every part of the country easily accessible and have facilitated the transport of surplus produce to the coast or to places where it is in deficiency ; and by the gradual development of a magnificent system of irrigation works, which have enormously increased the productiveness of the soil and rendered it capable of supporting with ease, even in years of extreme drought, the immense population which has grown up since anarchy ceased to exist, and the dreadful ravages of famine have been repressed. Almost entirely this has been the direct work of the Government but private agency, in an almost equal degree, has been relied upon to turn to advantage the facilities for transport and

irrigation, which have been created. A large measure of success has attended this policy ; the railways carry a heavy traffic, but it is mostly raw produce or imported manufactures. The water rendered available for irrigation is fully utilised, but the methods of cultivation are primitive, and agriculture has advanced to an inappreciable extent. It yet remains to give India that industrial life which will supply a sufficient diversity of occupations to absorb the intellectual unrest generated by the extension of education, and at the same time create a wider diffusion of material prosperity without which it is impossible that there should be any great improvement in the social condition of the people.

At the time of my arrival in India the necessity for doing something in this direction had been recognised, and there was a fairly general movement in favour of technical education. Something was done, but the difficulties of the situation were not properly appreciated, and the inevitable failure of the first efforts caused disappointment. The engineering progress of the last twenty years has done much to intensify this feeling, for whilst India has greatly benefited by the accelerated rate of development, the actual work has been accomplished by outsiders, and the people of the country can claim only a small share in the achievements, so that to-day they are nearly as dependent on imported technical skill and experience as they were when first they began to realise their deficiencies. Despite the ravages of plague and the widespread distress caused by a succession of partial failures of the monsoon, the foreign trade of India has made marvellous strides, but there is a limit to the expansion of the export of agricultural produce and that limit is probably not far off. The price of food-stuffs has nearly doubled within the last few years, bringing great prosperity to the land-owning classes, but entailing

much discomfort, if not actual distress, among the landless labourers, coolies, artizans, and others, whose incomes have not risen proportionately. Wages have increased to some extent, but the upward movement is slow.

The improvement of agriculture, which may be confidently expected as the result of the operations of the scientific staff now employed in all the Provincial Departments of Agriculture, will probably create an increased demand for labour, employed in a more intelligent way, to cultivate the soil, and to a more abundant and more valuable return than has hitherto been attained. It is in this direction, rather than in industrial openings, we must look for a solution of the labour problems. Favoured in the matter of climate and simple in their habits of life, the people of India require for their comfort and well-being but a small fraction of the necessities for existence in colder climates. The proportion of artizans to agriculturists is small, and would be much smaller if the artizans were better instructed and employed on modern methods of production. The industrial question has become of importance, because of the surplus educated class which has grown up in recent years, and for whom suitable work must be found.

The free trade policy pursued by England during the last sixty years has of late been subjected to severe criticism, but there is not the least doubt that its imposition on India, though it has possibly entailed hardship, and even suffering in some directions, has on the whole been distinctly beneficial to the country. Yet it is absolutely certain that if India enjoyed autonomy in fiscal matters it would reverse the present policy, and establish protective duties with the object of fostering industrialism within its own borders. The European mercantile community would, with good reason, welcome it as affording increased facilities for extending their sphere of operations ; the educated

natives would equally welcome it, because they think that behind the sheltering screen of protection they would be able to take an increasingly important part in the industrial movement. The dumb millions would have no voice in the matter. There can, I think, be no question that the introduction of an avowedly protective system would greatly stimulate industrial activity, but it seems more than doubtful whether the educated natives would be able to achieve their aims. They lack experience of manufacturing operations on a large scale, their technical knowledge has yet to be acquired, and their command of capital is limited. On the other hand, protection would attract capital from abroad, and with the capitalist would come the technical expert and the trained organiser of modern industrial undertakings. Success would undoubtedly attend their efforts, and India would contribute labour and raw material. The educated Indian would play but a small part, and he would in course of time realise that the protective duties, mainly served to enable Europeans to exploit the country.

It can hardly be doubted that this would increase the discontent with the existing regime and foster the growth of seditious movements. We have imposed free trade on India because we have adopted it ourselves, and the majority of the British nation hold that in the long run it is the best policy that any nation can pursue. If in the British Isles we cease to hold that view we must allow the Indian Government to alter its fiscal policy also. It is almost inconceivable that the manufacturing districts of the North will consent to a change in policy that involves the partial closure at least of the Indian markets to their trade. Capital and technical skill might, and probably would, migrate to the East, but the operatives would suffer from the dislocation of trade, and it is difficult to see how India would benefit from the sudden establish-

ment in its midst of an alien industrial system foreign to the habits and customs of the people. Protection I regard as no satisfactory solution of the Indian industrial problem, but rather as likely to increase the difficulties of the situation.

The experience of the past twenty years points to the conclusion that the mere provision of facilities for technical education, as it is understood in Europe, except for industries already established in the country, leads to no useful result. In schools and colleges only half the work of preparing men for industrial careers can be accomplished, and it has proved hopeless to expect that the pioneering of new industries can be undertaken by anyone who has had no business training and no opportunities of acquiring experience in the management of workshops or factories. Indian students who have spent years in Europe studying in some of the best technical institutions in existence have failed to make any headway on their return to India, chiefly because they have been unable to secure admission to manufacturing concerns, where alone they can obtain the knowledge of men and business essential to commercial success. The Japanese, it is true, were extraordinarily successful, but under conditions very different from those which now prevail. The manufacturing concerns, which were freely opened to them, are now strictly closed to Asiatics, and the opportunities they enjoyed of getting an insight into practical processes of manufacture can no longer be obtained. The Japs have proved serious trade rivals, and there is no intention in Europe of providing another Eastern race with the means to set up factories which will ultimately secure the trade which has been built up by patient efforts over many years.

India, therefore, must recognise that there is

no short cut to the industrial conditions necessary for her well-being, and that it can only be built up by adopting novel methods to meet the unprecedented state of things in the country. There has been much discussion as to what can be done, but it can hardly be said that any generally accepted plan has been evolved. State action in some form or other is recognised as essential, but in what direction it should be exerted is the subject of much controversy. No definite declaration of policy has been made by the Government of India, but each province within certain limits has been allowed to deal as best it can with the local situation.

In Madras I think it may be fairly claimed that we have gone further towards the adoption of a definite policy than in any other part of India and, as a natural consequence perhaps, we have aroused much opposition, and it is possible that we may yet be compelled to recede from the advanced position that has been taken up in regard to the functions of the State, and the extent to which it may legitimately take part in the creation of the industries. With the exception of a few cotton and jute mills, ginning factories, railway workshops, mining ventures, and private iron works, there are no large industrial undertakings in the Presidency, and no accumulations of capital in the hands of those who could with any prospect of success embark upon pioneer ventures in the industrial field. Private enterprise therefore is very weak, and those who would like to start work on a small scale are deterred by the initial difficulties they have to face, owing to the lack of independent experts in the various branches of industry to advise them how to proceed. We regard the provisions of such expert assistance, when practically possible, to be a legitimate undertaking on the part of the State. For some time past the Department of Industries

has undertaken such work, and its staff will shortly be strengthened by specialists in weaving, dyeing, and tanning.

The unsatisfactory state of the indigenous industries has been the subject of much enquiry, and not a little industrial experiment. In some cases important results have been obtained, and the way cleared for further work. Particular attention has been paid to the hand-loom weavers, as they are by far the most important class of artizans in the country, whether judged by their numbers or by the value of their annual out-turn, and I feel fairly confident in stating that the technical difficulties associated with improvements in their methods of manufacture have been overcome, and that it now remains to establish a suitable organisation among the weavers to enable them to more than double their rate of production. The control of that organisation will offer suitable employment to many of the educated classes, and help to bridge the gulf between the artizan and the intellectual castes.

We regard it as certain that much can be done by encouraging the use of modern machinery in place of manual labour, but it is necessary first to demonstrate on a practical scale the advantages to be derived from the innovation, and to determine beyond doubt that the plant to be recommended is suited to the limited mechanical skill that is available. Our most notable success in this direction has been the introduction of oil engines and centrifugal pumps for lifting water for irrigation. Already more than 300 pumping plants have been installed, and each is a centre for the diffusion of mechanical knowledge among the people, which in course of time will produce important results. The application of boring tools to the search for underground water supplies has proved equally successful, and to a lesser extent internal combustion engines have been

applied to driving sugar cane crushing mills, oil mills, and paddy hullers—all tedious and troublesome operations when cattle power was all that could be brought to the assistance of the miller. Where labour is extremely cheap, as it still is in India, it is often undesirable, even if practicable, to displace it by modern factory methods ; and the study of indigenous processes has been taken up with a view to improving them and rendering them more efficient, rather than with the object of displacing them altogether. It is fully recognised that the condition of the artizans and labouring classes can only be changed by rendering them more self-reliant and better workmen. Wages will only rise when the workers are capable of earning more, and we do not anticipate that any benefit will accrue to them from changes in the industrial methods unless they call for increased intelligence and skill. Industrial schools have not proved a great success, and better results have been obtained in demonstration factories where ordinary manufacturing conditions prevail, but such factories have been attacked as likely to interfere with private enterprise, and they may be regarded as still under trial.

The pioneering of new industries by Government has been undertaken, and the results have been satisfactory, but it has been bitterly attacked by the Chambers of Commerce and the local trades associations, as unsound in principle and an undue intervention of Government in commercial matters. The arguments adduced might be justly applied to countries where private enterprise is active, but in Madras they savour somewhat of a dog-in-the-manger policy that is not consonant with British traditions in the East. What the final outcome of the discussions will be rests with the Secretary of State for India, who alone can sanction the appointment of the technical experts necessary to carry out the policy I have

just outlined. The *laissez faire* policy of the Manchester school of economics, which was so widely accepted in the early Victorian era, has in these days of keen international competition fallen into disrepute, and the tendency of the times is to enlarge the functions of the State, through whose action much can be accomplished which is beyond the powers of private individuals or associations. In no direction is it more generally recognised that the State can do useful work than in the development and conservation of its own resources. The Congested Districts Board in Ireland and the Conservation Commission in Canada are examples that may be cited of State action analogous to that proposed for the creation of a healthy industrial activity in the Madras Presidency.

I have dwelt at some length upon our work in Madras, because it will to some extent influence the other provinces of India in dealing with their own special phase of the general problem, but I have no wish to convey an exaggerated idea of its importance. Educated India recognises that in industrial matters it is in leading strings, and the Swadeshi movement is the visible expression of its resolve to be free from them as soon as possible. The welfare of Great Britain is intimately bound up with the prosperity of its great Indian Empire, and to put the matter on no higher ground than that of purely selfish considerations, it is of vital importance to the expansion of our trade with India that industries should be developed out there, that labour should be properly trained and efficiently employed, so that the low standard of living that now prevails may be gradually raised.

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